WALLIN, J.E.W.

Measurement of mental traits in normal & epileptic school children.

THE MEASUREMENT

OF

MENTAL TRAITS

IN

NORMAL AND EPILEPTIC SCHOOL CHILDREN

By J. E. WALLACE WALLIN, Ph. D.,

Director Bureau of Special Education, and Professor of Clinical Psychology, Miami University

Author The Mental Health of the School Child, Problems of Subnormality, Experimental Studies of Mental Defectives, etc.

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M T 1

PREFACE

In our "*Experimental Studies of Mental Defectives*" we made a detailed analysis of the individual tests in the 1908 Binet-Simon scale based on the testing of epileptics while we had charge of the psychological laboratory and clinic of the New Jersey State Village for Epiletpics at Skillman. Since the publication of the above monograph we have published various other studies of the 1908, 1911 and Stanford revisions of the Binet scale.

The present study, the experiments of which were carried out during our connection with the Skillman institution, gives the results of a comparative investigation of epileptic and normal children by means of about a dozen independent psychological group tests. The publication of this monograph has been greatly delayed, partly because of our heavy schedule of work, leaving no time for working up researches except during off-hours, and partly because of the great difficulty during the last few years of securing publication of original experimental contributions, owing to the high cost of printing. The manuscript has been ready for some years. The value of the experimental results, however, is not impaired by the delay of publication, particularly in view of the fact that since this study was made not a single extensive experimental investigation has appeared on the psychology of epileptic and normal children.

The experiment here described is based upon the use of one of the first extensive sets of group tests devised for the measurement of intelligence, many of the tests being first used by the writer in an experiment under the auspices of the Oral Hygiene Committee of the National Dental Association, on a squad of children receiving special dental treatment. The use of group tests of intelligence did not become popular until the Army Alpha and Beta appeared. Since then scores of so-called group tests of intelligence have appeared in quick succession, embodying numerous refinements and improvements in the character of the tests used, and in the administrative and scoring technique. Literally millions of children and adults are now being tested and rated every year by means of these tests.

The tests used in this experiment were administered to 106 subjects in five successive sittings. All in all, we examined 5,839 record blanks; 4,179 of these were handed in by the normal children, and 1,660 by the epileptics. This includes the deferred recall of a number of tests (A2, F1, F3, G1, G3, G4 and K4) after the lapse of one month. Exclusive of the latter tests, 3,758 papers were handed in by the normals and 1,494 by the epileptics, or a total of 5,252. The number of record sheets in each test from A to J (exclusive of H) was somewhat over 360 for the normals and about 145 for the epileptics. It would be impossible within the limits of the time and space here available, to analyze this mass of data in minute detail. We have therefore taken pains to publish the original tables (which, however, contain only the quantitative tabulation). in unabridged form, so that they may be accessible to workers who may want to verify our results or who may want to pursue the analysis further than we have been able to do. However, while the complete data are given for each one of the epileptics studied, only averages are given for the normal pupils. We have separately tabulated the results for groups of "*bright*," "*average*" and "*dull*" public school children arranged according to school grade. These data are not included in the present study. They will be made available to anyone who has the time to work them up.

J. E. W. W.

CONTENTS

I. INTRODUCTION

The following research was carried out upon epileptic and normal school children during five successive months. The normal children, so-called, were pupils enrolled from the second grade to and including the eleventh grade of the public school in Hopewell, N. J. (this school did not contain a twelfth grade, or a fourth high school year), while the epileptics were attending the school in the New Jersey State Village for Epileptics at Skillman. The principal and teachers in the school at Hopewell were requested to select from each grade above the first for the investigation two dull boys and two dull girls, two average or medium boys and two average girls, and two bright boys and two bright girls, making a total of 120 children. The teachers were asked to rate the pupils not only on the basis of the proficiency they had shown in the school work, but also on the basis of the teacher's independent estimate of their intelligence. Actually 99 children were selected by the school staff as meeting the specified requirements. Twenty-three of these children, however, had to be rejected from the final tabulation, either because they failed to attend regularly on the test days or because they moved from the district. No one among the normal pupils was included in the final summary who was absent on more than one test day (although two papers were lacking for three subjects in three different tests, and two papers for three subjects in test K4). Unfortunately quite a number of the normals missed one of the sittings, the number of misses varying from 4 to 19 in tests A to I. Some of the pupils came late and thus missed some of the tests, while a few evidently failed to pass in some of their papers. (The papers were collected at the conclusion of each test.) Of the 76 normal pupils whose records could be included in our tables, all of whom were white except one colored girl, 39 were girls and 37 boys, approximately an equal number of boys and girls.

The pupils were classified as average, dull or bright by the school staff before the beginning of the experiment in January and again after the conclusion of the experiment in May. The classifications were the same in January as in May for all the pupils except three. The classification of one of these was changed from average to bright, one from bright and one from dull to average. According to this classification, 28 of the pupils were "bright" (12 boys and 16 girls), 29 were "average" (16 boys and 13 girls), while 19 were "dull" (9 boys and 10 girls). The distribution of the bright, average and dull pupils in each age is given in Table 1.

TABLE 1

Number of Dull, Average and Bright Pupils among the Normal Children in each Chronological Age.

Age	Dull			Average			Bright		
	Boys	Girls	Both	Boys	Girls	Both	Boys	Girls	Both
7	1	0	1	1	0	1	0	2	2
8	1	1	2	5	1	6	2	1	3
9	1	1	2	1	1	2	1	2	3
10	0	1	1	2	1	3	2	1	3
11	2	2	4	1	3	4	0	3	3
12	1	2	3	2	0	2	2	1	3
13	0	0	0	2	1	3	2	1	3
14	2	2	4	0	3	3	2	2	4
15	0	0	0	1	0	1	1	2	3
16	1	0	1	0	2	2	0	1	1
17	0	1	1	1	1	2	0	0	0
Total	9	10	19	16	13	29	12	16	28

According to the arbitrary age-grade standards (Grade I, 6 years; Grade II, 7 years; Grade III, 8 years, etc.), 21 of the pupils (6 girls and 15 boys) were accelerated in amounts ranging from one to two years, while 35 pupils were retarded (23 girls and 12 boys) from one to four years. But the average amount of pedagogical retardation was only .39 year (.08 for the boys and .68 for the girls). The average chronological age of the boys was 11.47 (varying from 7 to 17.08 years), while their average school grade was 6.2 (median 6); and the average chronological age of the girls was 12.3 (varying from 7.25 to 17 years), while their average grade was 5.9 (median 6). The corresponding figures for the entire group are 11.80 and 6. It appears from the pedagogical status and from the teachers' estimates that we are dealing with a good group of normal children, perhaps somewhat superior to the average. Probably not more than one pupil in the entire group approximated the feeble-minded status.[1]

The experiment began with the 39 ablest epileptics in the school department of the State Village. This number was subsequently reduced to 30, 16 boys and 14 girls (all white), owing to the elimination of 6 pupils who were unable to perform the tests because of their low mental status, owing to the demise of one boy and owing to the rejection of the records of two pupils who were very irregular in attendance because of convulsions. Although all of the epileptics whose records are utilized were present on all of the test days, from 3 to 6 missed one or more of the tests in a given sitting, owing to the fact that they had just had a convulsion before the testing began, or had a convulsion during the course of one of the tests, while an average of one epileptic was unable to take one or more tests in two sittings for the same reason. The average chronological age of the epileptic boys was 14.56

[1]For a representative normal group selected on a somewhat similar basis see J. E. Wallace Wallin, Psycho-Motor Norms for Practical Diagnosis, 1916, p.9ff.

(ranging from 10.58 to 17.83); of the epileptic girls 15.76 (from 10.83 to 24.25); and of the entire group 15.11. (See Tables 2 and 3.) The epileptic boys averaged 3.09 years older than the normal boys; the epileptic girls 3.45 years older than the normal girls, and the epileptic group 3.31 years older than the normal group. Only 26.6% of the epileptics as against 63.1% of the normal children were 12 years or less in age. On the other hand, 73.3% of the epileptic but only 36.8% of the normal children were over 12 years old. Whatever advantages attach to greater age or physiological maturity were decidedly in favor of the epileptic group. Although the epileptic children thus averaged considerably older chronologically than the normal children, they were inferior or less mature mentally. This is shown both by their pedagogical status and by their mental age.

The average amount of pedagogical retardation for the epileptic boys was 7.0 years, for the girls 7.3, and for the epileptic group 7.2, based on the standards given on page 6. (No epileptic, however, was considered as over 17 years in determining the amount of pedagogical retardation.) This is many times larger than the corresponding figures for the normal children, p. 6. All of the epileptics were retarded in amounts ranging from a minimum of two years for the girls (one case) and 4 years for the boys (two cases), to 10 years plus for the girls (2 instances) to 9 years for the boys (4 instances). The decidedly more favorable figures on acceleration and retardation for the normal children are given on p. 6.

Thirty per cent of the epileptic boys were doing first grade work; 30% second grade, and 40% third grade work; 28.5% of the epileptic girls were in the first grade, 35.7% in the second and 35.7% in the third; 30% of the entire group were in the first grade, 30% in the second, and 40% in the third grade. No one did work beyond the third grade. On the other hand, only 18.4% of the public school children were in grades II and III (none in Grade I), while 81.5% were in Grades IV to XI (Third High); 56.5% were in Grades II to VI, and 43.4% in Grades VII to XI. The average school grade for the epileptic girls was 2.3 (median 2.), for the boys 2.1 (median 2.) and for the whole epileptic group 2.1 (median 2.). The normal group averaged about four grades higher.

The average Binet-Simon age (1908, the writer's guide[1]) of the epileptic boys was 10.1 (median 10.2), of the epileptic girls 9.7 (median 10.4), and of the epileptic group 9.9 (median 10.4). On the supposition that the average mental or intelligence age of the normal group corresponded approximately to their chronological age, the normal boys averaged 1.37 years higher mentally than the epileptic boys, the normal girls 2.61 years higher than the epileptic girls, and the normal children 1.9 years higher than the epileptic

[1]The Binet tests were given in 1910 and 1911 before the 1911 revision had appeared, hence it is impossible to compute the results in terms of both the 1908 and 1911 scales, as we have done elsewhere for other subjects.

children. Relatively the epileptics are decidedly more deficient pedagogically than mentally.

Twelve and five-tenths per cent of the boys (2 cases) graded B.-S. VIII years,[1] 18.7% (3 cases) IX years, 50% (8 cases) X years, and 18.7% (3 cases) XI years; 28.5% (4 cases) of the girls graded VIII years, 14.3% (2 cases) IX years, and 57.1% X years. In other words, 20% (6 cases) of all the epileptics reached a mentality of VIII, 16.6% (5) of IX, 53.3% (16) of X and 10% (3) of XI.

The average amount of Binet-Simon retardation was 4.3 years for the boys, 6.0 for the girls and 4.8 for both sexes, the retardation being determined in every case by subtracting the exact Binet-Simon from the exact chronological age (both expressed in decimals), a method known to be faulty for older adolescents. One boy and one girl were retarded from .3 to .5 year; 1 boy and 2 girls from 1.0 to 1.4 years; 2 boys and 1 girl from 2. to 2.6 years; 4 boys from 3.0 to 3.8 years; 2 boys and 1 girl from 4.0 to 4.3 years; 2 boys and 3 girls from 5.0 to 5.9 years; 1 boy and 2 girls from 6.0 to 6.6 years; 2 boys and 1 girl from 7.0 to 7.4 years; 1 boy and 2 girls from 8.1 to 8.5 years; and one girl 10.5 years. Five epileptics had a B.-S. retardation of less than one and a half years, eight had a retardation less than two and a half years, and 12 less than four years. Twenty-two had a retardation of three and over; 18 of four years and over; 15 of five years and over; 10 of six years and over, and 7 of seven years and over.

What percentage of the epileptics was feeble-minded? On the basis of the hypothetical three-year retardation standard, 75% (12) of the boys were feeble-minded, 71.4% (10) of the girls, and 73.3% (22) of the whole group. On the basis of the four-year retardation standard, 60% of the entire group would be feeble-minded. On the basis of the IX-year upper threshold of feeble-mindedness,[2] only 31.3% (5) of the boys, 42.8% (6) of the girls and 36.6% (11) of the whole group were feeble-minded. None of these arbitrary standards, or others, however, can be rigidly applied to the diagnosis of feeble-mindedness in epileptics. For example, many epileptic children retarded only one year mentally will, no doubt, have to be diagnosed as feeble-minded, because it is very probable that they will fail to develop mentally, or they will slowly deteriorate. The tendencies toward arrest or deterioration for this group of children can be seen from an inspection of Tables 2 and 3. These tables are based on data sent me by Dr. D. F. Weeks, Superintendent of the New Jersey State Village for Epileptics, after four and a half years of further training. Twenty-two of the children were in residence at the institution at that time. The average pedagogical grade in the academic work of the nine who were still in school was 2.7 as against 2.1 at the time of the first report, an average pedagogical gain of only half a year

[1]Age VIII includes everything from 8. to 8. 8, and similarly for the other age designations.
[2]See J. E. Wallace Wallin, Problems of Subnormality, 1921, Chapter II.

in four and a half years. Sixteen, or 72.7%, of the 22 were reported as having retrograded pedagogically, only two were said to have improved pedagogically (although five of the nine in the school were classified in a higher grade), while four were recorded as stationary. Mentally 17 were reported as having retrogressed, two as having improved and three as having remained stationary. At the time of the examination the writer estimated that 64.3% (9) of the girls, 62.5% (10) of the boys, or 63.3% (19) of the whole group were feeble-minded, all belonging to the higher grade of feeble-mindedness. On the other hand, according to the estimates sent by the institution over four years later, all of the patients in residence were feeble-minded, assuming that the word "moron" was used as synonymous with the highest grade of the feeble-minded.

TABLE 2

Data on Epileptic School Children at New Jersey State Village at Skillman. During Experimental Period.

Subject No.	Sex	Chron. Age	B.—S. Age	School Grade	Type of Convulsions during period of Experiment	Approximate Frequency per month of Convulsions at time of Experiment	Onset of Convulsions Age of incidence	Etiological or pathological factors, so far as known	Extent of use of bromides during experimental period.
108	G.	12.33	8 2	1st	Grand and petit mal	61.8	10 months	Dentition	To control series
95	G.	17.16	8.6	2nd	Grand and petit mal	[illegible]	9 years	Unknown	To control series
79	B.	12.08	8.8	1st	Grand and petit mal	9	11 months	Indigestion	To control series
103	G.	15.41	8.8	2nd	Grand and petit mal	19	1½ years	Dentition	To control series
87	B.	17.50	9.0	3rd	Grand and petit mal	35.4	13 years	Unknown	To control series
100	G.	16.50	9.2	3rd	Grand and petit mal	9	1 year	Unknown	To control series
86	B.	13.58	9.2	1st	Grand mal only	15.6	8 month	Unknown	To control series
93	B.	13.00	9.3	1st	Grand and petit mal	15	3½ years	Unknown	To control series
102	G.	10.83	9.4	3rd	Grand and petit mal	[illegible]	6 years	Indigestion	To control series
83	B.	15.75	8.3	2nd	Grand and petit mal	9.7	5 years	Unknown	To control series
78	B.	16.00	10.1	2nd	Not in the village	.....	.....	.....	.....
91	B.	12.41	10.2	1st	Grand and petit mal	9.8	5 years	Pertussis	To control series
81	B.	10.58	10.2	1st	None	None	8 years	Unknown	Unused
106	G.	16.50	10.4	2nd	Not in the village	.....	.....	.....	.....
104	G.	10.91	10.4	1st	Grand and petit mal, nocturnal	20	8 months	Dentition	To control series
99	G.	11.75	10.4	1st	Grand mal only	5.4	10 months	Dentition	To control series
105	G.	18.58	10.4	2nd	Not in the village	.....	.....	.....	.....
107	G.	21.16	10.6	3rd	Grand and petit mal	51	13 years	Puberty	To control series
89	B.	14.00	10.6	3rd	Not in the village	.....	.....	.....	.....
97	G.	13.00	10 6	1st	No convulsions during period	Unknown	2½ years	Unknown	Unused
96	G.	16.08	10.4	3rd	Grand and petit mal	·37	7 years	Trauma of head	To control series
98	G.	16.41	10.6	3rd	Grand and petit mal	11	2 years	Dentition	To control series
85	B.	16.91	10.6	3rd	Grand and petit mal	18.1	6 months	Unknown	To control series
88	B.	16.75	10.8	2nd	Grand and petit mal	8	8 years	Unknown	To control series
80	B.	15.16	10.8	2nd	Not in the village	.....	.....	.....	.....
90	B.	17.83	10 8	3rd	Grand and petit mal	19.3	5 years	Overdose of ether	To control series
84	B.	12.41	11.0	3rd	Not in the village	.....	.....	.....	.....
77	B.	14.00	11.4	3rd	Not in the village	.....	.....	.....	.....
82	B.	15.00	11 2	3rd	Not in the village	.....	.....	.....	.....
101	G.	24.00	8 2	2nd	Grand and petit mal	7	17 months	Dentition	To control series

TABLE 3

Data on Epileptic School Children at New Jersey State Village at Skillman. History Four and ½ Years Subsequent to Experimental Period.

Subject No.	Type of Convulsions	Frequency of Convulsions per month	Present School Grade	Improved or retrograded pedagogically?	Improved or retrograded mentally?	Present classifications (Imbecile, moron, borderline, backward, etc.)
108	Grand and petit mal	12	2nd	Improved	Improved	Imbecile
95	Grand and petit mal	2.4	2nd	Retrograded	Retrograded	Middle imbecile
79	Grand and petit mal	10.6	4th	Retrograded	Retrograded	Imbecile
103	Grand and petit mal	11.1	Not in school	Retrograded	Retrograded	Low imbecile
87	Grand and petit mal	32 3	Not in school	Retrograded	Retrograded	Imbecile
100	Grand and petit mal	6.1	3rd	Retrograded	Retrograded	Middle grade imbecile
86	Grand mal only	10	Not in school	Retrograded	Retrograded	Imbecile
90	Grand and petit mal	19	Not in school	Retrograded	Retrograded	High grade imbecile
102	Grand and petit mal	9.6	2nd	Retrograded	Retrograded	Middle imbecile
83	Grand and petit mal	9 2	Not in school	Stationary	Stationary	Moron
78	Not in Village					
91	Grand and petit mal	26	Not in school	Retrograded	Retrograded	Middle imbecile
81	Grand and petit mal	33.2	Not in school	Stationary	Retrograded	Moron
106	Not in Village					
104	Gd. and pt. mal noctl.	16	2nd	Retrograded	Retrograded	Moron
99	Grand mal	43.5	Not in school	Retrograded	Retrograded	Imbecile
105	Not in Village					
107	Grand and petit mal	31	Not in school	Retrograded	Retrograded	Low imbecile
89	Not in Village					
97	No Convulsions		Not in school	Stationary	Stationary	Moron
96	Grand and petit mal	24.9	2nd	Retrograded	Retrograded	Middle imbecile
94	Grand and petit mal	13.3	Not in school	Retrograded	Retrograded	High grade imbecile
85	Grand and petit mal	16.7	5th	Improved	Improved	Moron
88	Grand and petit mal	7.6	3rd	Stationary	Stationary	High grade imbecile
80	Not in Village					
92	Grand and petit mal	23.9	Not in school	Retrograded	Retrograded	Imbecile
84	Not in Village					
77	Not in Village					
82	Not in Village					
101	Grand and petit mal	6	Not in school	Retrograded	Retrograded	Middle imbecile

At the time of the experiment eighteen of the epileptics suffered from both the grand and the petit mal type of convulsions, two from the grand mal type alone, two did not have any seizures, while the data are not recorded for eight of the subjects. The later record indicates that 19 were suffering from grand and petit mal seizures, two from grand mal (the same subjects as before), one had no seizures (this girl had no seizures in 1911), while the data are lacking for eight subjects. The seizures were of the mixed type in the vast majority of cases for which the data are supplied. The details in regard to the frequency of the convulsions are accessible in the tables. Our group of epileptics shows the usual variation in the frequency of the attacks. Bromides to abort seizures were not used at the institution except in the case of serial attacks (status epilepticus). The subjects accordingly were comparatively free during the experimental period from bromidic hebetude. The convulsions began at or before the age of 8 years in 19 cases, after the age of 8 in 3 cases, while no data are given for eight subjects. The onset occurred before the age of 6 in 15 cases, and before the age of 3 years in 11 cases.

In addition to the above facts, we recorded data on the condition of each epileptic during the different sittings. The following are some of the more significant items:[1]

No. 108 was in a worse mood than usual during most of the second sitting. She did not do so well in some of the tests during this sitting.

No. 95 had convulsions the night before the second sitting, and only made feeble efforts in the tests. She was out of the room part of the time. She suffers from the after-effects of convulsions.

No. 79 was below normal during the first sitting, having had a convulsion earlier in the morning. During the fifth sitting he had a convulsion just before test C was to be given, but partook in some of the later tests.

No. 103 had a seizure 10 minutes before the tests started in the second sitting, and did nothing in most of the tests on this day.

No. 86 said he felt good during the second sitting. On the day of the fifth sitting he had had two grand mal seizures. He did poorer during this sitting in practically all the tests in which he had previously made scores.

No. 93 was reported sub-efficient during the first sitting, owing to the fact that he had had two convulsions earlier in the morning. His record in the tests was perhaps somewhat below normal during this sitting.

No. 102 had a convulsion during the latter part of the second sitting. She appeared drowsy a short time before and did nothing after the convulsion. During the third sitting she said she was sick. She had a convulsion before coming to the class and was reported to have been stupid all week. She did poorer in most of the tests during these sittings.

No. 105 was somewhat stupid and refractory during the third sitting and more or less stupid during the fourth sitting, but did as well as usual in some of the tests.

No. 96 had a convulsion before the tests began during the first sitting, and had a convulsion after test A had been given during the fourth sitting. She returned after test D had been given.

The aim of the psychological experiment was to measure under controlled conditions the comparative amount of change or development which might occur in various mental traits among various grades (bright, average, dull) of normal pupils of different ages and school grades and among epileptic school children, during the same intervals of time and under the same experimental conditions. To be able to measure mental changes we must have at hand a set of mental tests each of which is so simple of comprehension and execution that it can be given to children of various ages, each of which must be so scored that the youngest children will be able to make a score above

[1]Data on the condition of the normal children during each sitting were also gathered. We cannot take the space to detail these.

zero, while the oldest or the ablest pupils must not be able to make a perfect score, and each of which must be constructed in a successive series of tests of the same degree of difficulty.[1]

It is evident that if each successive test increases in difficulty, the mental development will be minimized or neutralized by the increasing difficulty of the successive tests themselves, while, on the other hand, if the successive tests decrease in difficulty the mental improvement will be exaggerated. In an ideal set of serial tests designed accurately to measure mental growth or improvement the successive tests of the same series must be absolutely uniform in difficulty, but it is difficult to construct such uniform series, and this is true in some tests more than in others. The difficulty is increased by the fact that, owing to the influence of the factors of familiarity, practice and memory, it is not permissible—or at least it is inadvisable—to use precisely the same test material in each of the successive tests. However, by introducing certain changes in the arrangement of the same material, or by using new material of the same degree of difficulty in each of the successive tests, we shall be able to combat, in part at least, the influence of the factors of familiarity, practice and remembrance which inevitably make themselves felt in repeated reactions to identical test materials. The introduction of alterations, however, may make it difficult to secure *absolute uniformity* in the different successive tests, particularly when entirely new materials are introduced, as we shall see later. But the inequalities thus produced are less objectionable than the repeated employment of exactly the same test materials. In fact, it would be impossible to employ the same materials in some of our tests (e. g., the spontaneous association and antonym tests) during the five sittings in which the tests were conducted.[2] In the following tests the same materials were used, but in a rearranged form, in all of the successive sittings: immediate reproduction of memorized three-place digits (A), and speed and accuracy of perceptual discrimination (E). The same letters were also used in some of the word building tests (I). The arrangement of the digits in the later addition tests (C) was secured by a systematic rearrangement of the digits in the earlier tests. In the following tests new materials were introduced in each successive test: spontaneous association with supplied key-words (B), the giving of antonyms to match supplied key-words (D), range of visual apprehension (F), immediate recall of sequents (or antecedents) in presented paired associates (G), visual imagination with ink blots (H), sentence construction with three supplied words (I), and recognition of illustrated post cards (K). The detailed nature of the test materials used may be seen by examining the following chapters in which the materials are described, or those used in the first sitting reprinted.

[1]We have elsewhere discussed these and other conditions of a series of tests of this nature: Dental Cosmos, 1912, p. 545f.

[2]The tests were constructed in six series, but it was impossible to conduct the last sitting.

Practically all of the tests used came within the lower limit of ability of the least capable or the youngest normal pupils who were tested. Only in one test, J, did as many as seven subjects fail in all five sittings, while 16 failed in the first sitting. Even in this test, however, some of the youngest subjects scored in some of the sittings. In only one other test, C, based on the correct additions only, did more than one subject fail in the five sittings. Three failed in all the sittings in this test. In six tests there was one failure in all five sittings, but this was made by the same subject, a seven-year-old boy in the second grade, classified as dull, who was more or less restless and who usually applied himself very poorly. A number of subjects, particularly the younger ones, grew more or less inattentive during the course of the testing, i. e., during the last two or three sittings. A few made little effort in some of the tests in the later sittings, while a few attempted to interfere more or less with other pupils. These factors resulted, no doubt, in slightly reducing the general averages. There was not a single failure in any sitting in three tests (A, E and L), while in five others less than three pupils failed in any one sitting.

On the other hand, the tests were administered under such rigid time limitations that only a few of the ablest pupils were able to finish the test or make a perfect score. Only six different subjects made perfect scores in any one sitting in any of the tests (all in the three last sittings), and no subject made perfect scores in more than one sitting of the same test. Only one subject—a 16-year-old girl classed as "bright"—made a perfect score in one sitting each of two tests, namely in the antonym (D) and recognition (K) tests. Perfect scores were made in only three tests, the antonym test (D), by one subject, the paired associates tests (G), by four, and the recognition test (K), by two. All of the subjects who made these perfect scores were 14 years old or over, except one, who was 11 years. All were in the seventh grade or above except the 11-year-old (sixth grade). Three of these pupils were classed by the teachers as bright, one as average and two as dull. One of the latter was the 11-year-old boy who may have been rated dull relatively to older pupils in the sixth grade.

The responses to all the tests required the use of a lead pencil, since they were designed as group tests and all were so administered. Had the tests been given individually or clinically, so that the responses could have been made verbally instead of in writing, in the tests which permitted of verbal responses, the scores would, of course, have been higher, at least in some of the tests and especially so far as concerns the younger children and many of the epileptics, whose responses were impeded by the inability to write rapidly and by uncertainty as to the spelling of words. To minimize this handicap the children were urged to write as rapidly as possible irrespective of the beauty of the penmanship and irrespective of the correctness of the ortho-

graphy. The pupils were told that misspellings did not count, and that, therefore, they should not lose any time pondering over the spelling of uncertain words, but spell as well as they could.

The tests were given at intervals of twenty-eight days between January 17th and May 9th. We should have preferred giving them at longer intervals, every third or sixth month, but the time available for the experiment made this impossible. We would emphasis, however, that the tests were given to our two groups at precisely the same intervals of time—the normal pupils on Tuesdays and the epileptics the following day. Moreover, both groups were tested during the same part of the day, the normal pupils in three different groups between 9 A. M. and 12 M., and the epileptics in two groups between 9 and 11 A. M. The weather conditions were good on all of these mornings, except that the sky was cloudy during the February test, and the weather was rather warm and sultry during the May test. The epileptics seemed to be in a better condition during the May sitting than during any other sitting.

The time required to give all the tests to one group of children was approximately one hour. The same rooms, well lighted and free from noise—both recitation rooms, the one in the public school and the other in the school for the epileptics—were used in all the sittings, and the pupils occupied their assigned seats on all of the test days. The tests were all administered by the writer, under rigidly uniform conditions.

The tests were timed by means of a stop watch. The instructions were given in a clear, loud tone of voice, easily audible in all parts of the room, while the materials displayed in the memory (A) and observation (F) tests were easily visible from any seat in the room occupied by the pupils. Two assistants aided in the distribution and collection of the papers and served as "watchers," in order to lessen the temptation of the pupils to copy each other's papers. The pupils were explicitly warned not to copy and no copying was observed.

The general procedure which was followed in giving the tests is indicated by the following directions (the statement is slightly modified to meet the present needs) which accompany the test materials.[1]

GENERAL DIRECTIONS

Explain to the children at the outset that you are going to give them a series of tests or games, and that you want to see just how well they can do in the tests. Urge them before giving each test to do their very best; to work, to write, to think just as well and just as fast as possible. But do not

[1]The materials, including the six complete series in the different tests, can be obtained from C. H. Stoelting Co., 3037 Carroll Ave., Chicago, Ill., with the exception of F1 to 6, K4 and L5. Five of these tests (A, B, C, D and E were originally prepared for an experiment given under the auspices of the Oral Hygiene Committee of the National Dental Association: J. E. Wallace Wallin. Experimental Oral Euthenics. Dental Cosmos, 1912, 54:404-413; 543-566.

excite them. Have them work naturally, without undue constraint, fear or haste. Avoid suggesting the object of the entire investigation as such. Let the work appear as a phase of the regular routine of the day, or better still, as a series of interesting contests or games. But the subjects should do their best. The experimenter must be tactful.

Explain that you are going to place blanks (sheets of paper) on the desks upside-down; that when you say "*ready*" they must take their pencils in one hand and at the same time take hold of the lower left corner of the papers with the other hand; that the very moment you say "turn" or "turn your papers" they must rapidly turn the papers over *sidewise (always sidewise)*, and begin to write at once; and that when the time is up you will say "*stop*." They must then cease writing at once; they must not write another letter, but instantly turn the papers over again. Make sure that all the subjects are ready before the starting signal ("turn") is given, and that everybody turns the papers the moment the "stop" signal is given. Explain that no pupil should stop to ask questions or to sharpen pencils while the tests are being given. Each pupil should have two pencils, well sharpened.

After the pupils have turned up the reverse side at the close of the first test, have them write at the top of the page: full name, sex, age (verify the age from the official records), date and hour of test, condition during tests (well, fresh, tired, sick, pains, etc.), school, and grade. At least the name must be written on the subsequent test blanks.

Absolutely uniform conditions must be maintained throughout all the tests; same seating, same instructions, same experimenter, if possible, same hour of day, uniform absence of distracting stimuli. The *time* set for each test must be *minutely* observed. The experimenter will always start the stop watch the very moment the cardboards are displayed (A1 to A6, F1 to F6, K4), or at the moment the starting signal is given ("turn"). He will stop the watch the moment the "stop" signal is given.

The pupils subjected to the tests should be especially urged to be present on the days on which the tests are scheduled. In case any are found to be absent, they may be tested during the corresponding hour on the first day of their return, but note must be made of this fact. (None was tested except during the regular sittings in this investigation.)

Pupils should be so seated as to avert possibilities of *copying*. They should be told that if they do copy the papers will be discarded. One or two helpers should assist the examiner to distribute the papers and keep tab on the pupils so that no copying can be done.

ORDER OF GIVING TESTS

One from each series should be given at each sitting. The order of the successive sittings is indicated by the numbers 1, 2, 3, 4, 5, and 6, printed at the bottom of the test blanks after the letters A, B, C, etc., 1 coming during

the first sitting, 2 during the second sitting, etc. The letters A, B, C, D, E, F, G, H, I, J, K, and L indicate the order in which the different kinds of tests are given in the same sitting, A coming first, then B, then C, etc. The tests follow each other as fast as they can be given. The following scheme will indicate the order:

During the first sitting: give A1, B1, C1, D1, E1, F1, G1, H1, I1, and J1. During the second sitting: A2, B2, C2, D2, E2, F2, G2, H2, I2, and J2.

The sittings may come at intervals of a month, two months, a half-year, a year, etc. Some may be given before the introduction of a special factor (e. g., dental treatment, administration of thyroid extract) and others at various subsequent intervals.

The directions for administering the individual tests are given in connection with the discussion of each test in the subsequent chapters.

EXPLANATION OF TABLES

The following explanations apply to all the tables which contain the original data, although some of the functions have been worked out for the first seven tests only.

No., number of subjects included in the averages. Since some of the subjects missed one of the sittings (and a few missed two) the number of subjects given in the first column of the tables for the normals does not hold for all of the sittings.

Su., subject; Ae., age; Sx., sex; B., boys; G., girls.

$\frac{1}{\%}$, $\frac{2}{\%}$, $\frac{3}{\%}$, $\frac{4}{\%}$, and $\frac{5}{\%}$, percentages of efficiency shown in the first, second, third, fourth and fifth sittings, respectively, given on the following dates for the public school children (and on the next following day for the epileptics): $\frac{1}{\%}$ $\frac{2}{\%}$ $\frac{3}{\%}$ $\frac{4}{\%}$ $\frac{5}{\%}$ Jan. 17, Feb. 14, March 14, April 11, and May 9. We shall refer to these successive test days as sittings, and to the per cents made during any sitting as scores or percentage scores.

The figures in the tables for the normals are averages except for age 16, boys, where there is only one subject. The averages for all the functions in all the tables were obtained by summating all the individual scores, whether for a given age or for all the ages or for either or both sexes, and dividing by the total number of cases.

The units for scoring the different tests differ widely according to the nature of the material used in each test. We have converted the scores in nearly all the tests into percentages, by giving a percentage value for each unit or part unit of work accomplished in the different tests, based on 100% as a perfect record. While there are certain advantages in reducing the results to a percentage basis, it should not be inferred that a given percentage

signifies the same degree of efficiency in the different tests. An inspection of the results in the tables of the different tests for the children of the same age shows that this is not so. A 50% efficiency in one test may be equal to a 75% efficiency in another test. Let us repeat, then, that there is no value equivalence between the same percentage scores in the different tests. It is evident that any one who may use the tests need not score the results in terms of per cents, as we have done, which involves a considerable amount of labor. We have found the per cent method convenient for scoring partial credits or making deductions for omissions or partial errors, and for expressing the results in a combined qualitative-quantitative score.

$\frac{1}{2}$%, average of the per cents for the first and second sittings (in test B, 2 and 3 are averaged), $\frac{4}{5}$%, same for sittings 4 and 5; $\frac{1}{5}$%, same for sittings 1 to 5. In averaging the scores for different months whenever the subject was absent during one of the sittings the score in the next preceding or next following sitting was substituted (except in test B, in which the January results could not be used, because of difference in time). Thus January and March were averaged when February was lacking, or March and April when May was lacking, or March and May when April was lacking. The irregularities produced by this procedure are perhaps usually less objectionable than using the results from a single month for an average.

Owing to occasional absences the results for $\frac{1}{5}$% are sometimes based on less than five sittings. In all cases the figures in the columns $\frac{1}{5}$% are based on the total score for all the monthly tests divided by the actual number of sittings in which a given subject was present. The age averages for each sex or the two sexes in $\frac{1}{5}$% were not obtained by dividing the totals of all the scores by the number of subjects included in the given age, but by the number of separate scores included in the total. The final averages were obtained by dividing the grand total of all the monthly scores by the total number of individual scores made by all the subjects.

There are two methods by which the improvement made in each test from sitting to sitting can be determined. First, we may calculate the difference between the average scores made in each test. Thus, the difference between the averages of the first and the second sittings for all the normals in Table 4, is 5.4% (a gain); between the second and third sittings .4% (gain); between the third and fourth sittings 4.4% (gain); between the fourth and fifth, –4.5% (a loss); between the average of the first two sittings and the average of the last two 5.2% (gain); and between the first and the fifth sittings 5.7% (gain). This supplies a simple expression of the improvement in terms of absolute units, but it is not an entirely satisfactory method because the relative amount of improvement made by different subjects or different groups of subjects depends less upon the absolute units of gain made than the amount of gain made in proportion to the degree of efficiency—the

size of the scores—shown in the initial test. To express the relative amount of gain we have employed the following indices of improvement:

$f\frac{2}{1}$: this represents the index of improvement shown in the second sitting as compared with the first. It is obtained by dividing the percentage score made in the first sitting into the percentage score made in the second sitting. To obtain the percentage of improvement made in the second sitting substract unity (1.0) from the quotient. To obtain the amount of loss substract the quotient from unity. Thus the improvement made by subject 84 in the second sitting of the memory test compared with the first sitting, Table 5, is 85%, obtained thus: Sitting 1 (23.3) divided into sitting 2 (43.3%)=1.85. 1.85—1.00 (unity)=.85 (=per cent of gain). On the other hand, subject 104 lost 50%: Sitting 1 (13.2%) divided into sitting 2 (6.6%)=.50. 100 (unity)—.50=.50 (=per cent of loss). An index of 1.0 (unity) indicates that the subject neither gained nor lost. Such a record is shown by subject 82, in sittings 1 and 2, Table 5: 36.6%÷36.6%=1.00. 1.00—1.00=0 (=neither loss nor gain). Accordingly in $f\frac{2}{1}$ the relative value of the score in 2 is determined by the size of the score in 1, regarded as unity, whence the index indicates the relative amount by which sitting 2 is larger or smaller than sitting 1.

The following indices of improvement, $f\frac{3}{2}$, $f\frac{4}{3}$, and $f\frac{5}{4}$ are obtained similarly, by dividing the score in the second sitting into the score in the third, the third into the fourth, and the fourth into the fifth.

Owing to the fact that a considerable number of subjects missed one sitting (and a few two sittings) it has frequently been difficult to compute the index. Rather than leave the index blank in such cases, it seemed desirable to substitute the score in the next sitting, either the one preceding or the one following. Thus, the January score would be divided into the March score when the February paper was missing, the February score would be divided into the April score when the March paper was missing, etc. It must be emphasized that this introduces certain unavoidable errors.

In $f\frac{4-5}{1-3}$, the average of the scores in sittings 1 and 2 is divided into the average of the scores in sittings 4 and 5 (the average of these sittings being given in columns 13 and 14). As we have already remarked, occasional absences made it necessary to substitute the score from an adjacent month to derive an average. Accordingly sittings 1 and 3, and 3 and 5 have sometimes been averaged.

The index $f\frac{5}{1}$, in the sixteenth column, shows the gain or loss made in the last sitting compared with the first. Infrequently it was necessary to divide 4 into 1, owing to absences in the fifth sitting. The division in all the indices was carried to two decimal places.

It should be pointed out that the indices in the tables for the public school cases have not been computed from the percentage scores given in these tables,

because these scores represent averages. The indices in these tables were obtained by finding the index for each subject separately, adding the indices thus obtained for all the subjects of a given age and then dividing the sum by the number of subjects who were present during a given sitting. The index so obtained is not identical, of course, with the index obtained by using the average scores as dividends and divisors. Thus the index $f\,\frac{2}{1}$ for the two 7-year-old boys in the memory test, Table 4, is 1.10. This figure was obtained by adding .70 and 1.51, the separate indices for the two subjects, and dividing by 2. The index obtained, however, by dividing the average score for these two subjects in sitting 1 (31.6) into the average score in sitting 2 (25.0) is .79. One reason why the average scores of a given age cannot be employed as a basis for computing the index is the fact that all the subjects were not present during all the sittings, whence the number of subjects averaged in one sitting would differ from the number averaged in the next sitting.

It would appear that the two methods of expressing the improvement, namely, by the absolute difference between the percentage scores and by the index, should always harmonize. A detailed examination of the tables shows that frequently they do not, either in the direction or in the amount of the change. Thus to take an extreme case: there was a loss for the boys in the second sitting of the addition test for the epileptics, Table 16, amounting to 21%, according to the second index of improvement ($f\,\frac{2}{1}$, .79, at the foot of the column). On the other hand, according to the difference between the percentage scores in sittings 1 and 2 there was an actual gain in efficiency in the second test, amounting to .8% (3.0% vs. 3.8%). What is the explanation of this discrepancy? It is due to the fact that it is impossible to calculate any index of improvement when the scores are zero in both of the sittings, or when the scores are zero in the first sitting. As a consequence the sum of all the indices in $f\,\frac{2}{1}$ cannot be divided by the same number of subjects as can the sum of the scores in sittings one and two. Thus, in Table 16, the sums in sittings 1 and 2 for the boys are divided by 16 and 15, respectively, while the sum of the indices in $f\,\frac{2}{1}$ is divided by only 6. The zero scores in 1 and 2 cannot be represented in $f\,\frac{2}{1}$, except when the zero is in the second sitting. The percentage of improvement in the second sitting cannot be ascertained when the initial score is zero, but when the score in the second sitting is zero there is an absolute loss which can be expressed as .00. This difficulty is frequently complicated by occasional absences, which makes it impossible to ascertain the index or makes it necessary to base the index on another sitting, so that frequently the data averaged in the index column are not identical with the data in the score columns. Under these conditions it is inevitable that discrepancies should arise. When there are no zero scores in the different sittings and when the subjects are all present the results by the two methods should harmonize. We base our conclusions regarding the

improvement made in the test largely on the indices. The reader can base the comparison on the first method, should he so desire, from the data supplied in the tables.

The $\overset{\text{Gain}}{\underset{1\text{-}5}{\text{Ave.}}}$ in the last column was obtained by finding the difference between the percentage scores in each successive sitting, 1 to 5 (the scores in the columns numbered 1, 2, 3, 4 and 5), then substracting the sum of the losses from the sum of the gains (or vice versa when the sum of the losses is larger than the sum of the gains) and dividing the remainder by the number of differences. To illustrate: the successive scores for subject 80 in Table 5, are 23.3, 16.6, 30, 13.3 and 50. The successive differences between these scores are −6.7, +13.4, −16.7 and +36.7. The sum of the gains (+) is 50.1 and of the losses (−) 23.4. Hence the total net gain for the 4 last sittings is 26.7, and the average gain for each successive sitting (i. e., the last four sittings) is 6.7. For subject 82, the successive scores are 36.6, 36.6, 33.3, 33.3 and 33.3. The successive differences are 0, −3.3, 0 and 0. The total loss for the 4 last sittings is 3.3 and the average loss .8.

The averages in the tables for "B", "G", and "B & G" at the bottom of the columns containing the percentage scores, were obtained by finding the sum of the individual scores for all the subjects and dividing by the total number of subjects in a given column. These averages were not obtained by averaging the different averages in the per cent columns. The final averages (at the bottom) for the columns containing the indices of improvement *(f)* were obtained in the same manner.

The computation of a large amount of the data in the tables was entrusted to two paid and two or three volunteer assistants. So many errors, however, were discovered that it was necessary to revise practically all of the tabular data. Doubtless occasional undiscovered errors in mathematics still remain, but it is not believed that these are numerous or serious enough to exert any appreciable effect on the final results.

In the following chapters we shall (1) reproduce or describe the test materials, (2) state the nature or purpose of the tests, (3) give the directions for administering the tests, (4) present the tabular data, (5) state some of the more important empirical results, and (6) finally summarize a few of the conclusions. We would emphasize that our conclusions are based upon the groups which we have actually studied and, owing to the limitations of these groups, must be regarded as more or less tentative. One chapter will be devoted to each test. In a final chapter we shall give a brief summary of conclusions. The descriptions of the tests will be somewhat brief in view of the fact that detailed directions for administering the tests will be given. The sections dealing with the description and with the administration of the tests are intended to supplement one another.

II. MEMORIZING VISUALLY PRESENTED NUMBERS

Immediate and Deferred Recall of Three-Place Digits: A1 to A5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

STIMULUS MATERIALS

The following figures were printed on cardboards[1] 7 inches wide by 26 inches long. The size of the type was such (1⅝ inches high) that the figures could be read easily from the most remote seat occupied by anyone taking part in the tests. Each card contains ten three-place digits.

A1	A2	A3
961	057	578
149	462	666
723	103	192
294	999	730
555	275	429
812	634	815
306	786	281
037	340	954
480	821	043
678	518	307

A4	A5	A6
185	590	888
714	238	305
098	111	219
026	983	763
479	409	076
201	726	934
333	875	152
857	064	690
560	657	421
642	342	547

RECORD SHEETS

The pupils' records were made on plain sheets of paper 4½ by 7½ inches. numbered from A1 to A5. These blank sheets were prepared by hand and are not included in the set published by the C. H. Stoelting Co.

[1]The complete s t of test materials will be printed although, as already explained, the sixth series was not given.

In the arrangement of the figures on the different cardboards care was taken that no number combinations would recur on the same card or on the successive cards, with the two following exceptions: First, the digits were made identical in one of the ten three-place figures on each card, thus: (1) 555, (2) 999, (3) 666, (4) 333, (5) 111, and (6) 888. These figures were given a different position on each card, so that the subjects would not acquire the habit of looking for a figure with identical digits in the same position in the series. It is possible that the subjects began to anticipate a figure with identical digits after the second or third sitting, although our results do not clearly indicate this, as will be seen later. Second, one figure in each card began with a cipher, thus: (1) 037, (2) 057, (3) 043, (4) 098, (5) 064, and (6) 076. These figures were also given a different position in the series on each card. The figures were systematically distributed on each card in such a way that each of the ten digits would occur but once in each vertical column. It was believed that a systematic distribution of the numbers in accordance with this plan would be most likely to yield a series of numbered cardboards of equal difficulty. No empirical tests, however, were carried out to demonstrate whether the successive number cards were uniform in difficulty. To make such a determination it would be necessary to give one each of the different number cards to different groups of children of the same intelligence status. The series of cardboards, however, can be validly used to measure the *comparative* performance of normal and epileptic children, even though they should prove not to be exactly equal in difficulty.

2. NATURE OR PURPOSE OF THE TEST

This test aims to measure the visual memory span for non-sense material (three-place digits). Or perhaps it would be more accurate to say that the test measures the ability to reproduce *memorized* non-sense materials, for it should be emphasized that this test requires actual memorizing during a period of 45 seconds, unlike the tests of memory (or attention) span proper, in which a single impression is given through a momentary exposure or a single repetition. The strength of memory (memory span) in the latter case depends upon the primary impressionability and retentiveness of the neurones, while the strength of memory in the former case depends upon these factors plus the depth of the impression produced by repetition. We have measured the subject's retentiveness of the memorized material in this test both by the method of immediate recall and of deferred recall.

3. DIRECTIONS FOR GIVING THE TESTS

General Instructions: follow the general directions on pages 15 and 16.

Order of Giving Tests: first sitting, A1; second sitting, A2; third sitting, A3; fourth sitting, A4; etc.

Time: Display the cards for exactly forty-five seconds. Allow the children exactly sixty (60) seconds in which to write from memory. Hold the cardboards so that the number can be easily seen by all the pupils in the room.

Instructions to be Given to the Pupils: "On the other side I have a set of numbers. The moment I turn the card around I want you to start to *learn* (memorize, commit) just as many numbers as you can. I want you to study just as hard as you can, because I am only going to let you see them for a little while. Then when I turn the card around again, I want you to turn your papers over at once (this, however, is not necessary with these vacant blanks. But this method was followed in giving the tests in this experiment, in order to employ uniform conditions in all the tests), and write down just as many numbers as you can remember. Write them just in the order you saw them, if you can; the first number at the top, the second number next, and so on. But if you cannot remember the order, write them as well as you can. (The important thing, of course, is to have the three digits in each number in the right order.) When I say 'stop' you must stop at once and turn your papers over again."

"Now, ready!" "Turn!"

"Now, stop!" "Turn your papers over."

At the Close of the Experiment: Pupils write full name, age, sex, date, hour, condition, school, and grade.

Ranking—How to Mark the Papers: Scale of 100.

Each correct number (all three digits right and correctly placed), 10%.

One digit of a number placed correctly, 3.3%.

Two digits placed correctly, 6.6%.

The sum of two of these should be scored 10%.

Always give results in terms of the per cent of efficiency (not inefficiency). No deductions have been made in this experiment for incorrect numbers.

On this rather liberal basis of crediting care must be taken lest credit be given for mere guesses. Combinations, if partly right in two or three figures (three-place groups), must be credited only once. Special records may be kept of 555, 999, 666, 333, 111, 888, and of 037, 057, 043, 098, 064, and 076.

Deferred Reproductions: At the beginning of the second sitting the experimenter may, if he chooses, ask the pupils to reproduce A1, without a second exposure, and similarly during any later sitting. But the pupils must not be told that they will be tested again on the test at the next sitting.

TABLE 4

Immediate Reproduction of Memorized Three-Place Digits: A1—A5

NORMAL CHILDREN

No.	Ae.	Sx.	1 %	2 %	f 2/1	3 %	f 3/2	4 %	f 4/3	5 %	f 5/4	1-2 %	4-5 %	4-5 / 1-2	f 5/1	1-5 %	Gain Ave. 1-5 %
1	7	B	31.6	25.0	1.10	29.9	1.36	35.0	1.19	20.0	.55	28.3	27 5	1 31	1 02	28.0	—3.7
2	7	G	29.3	30.0	1.28	28.3	.90	44 9	1 62	33.3	.74	27.4	39.1	1 42	1.18	33 3	1 4
4	7	Av.	27 4	26.3	1.16	29.1	1.13	39.9	1 87	26.6	.64	27.8	33.3	1 3b	1.10	30.8	—1.3
1	8	B	29.1	29.5	1.32	33.3	1.12	37.1	1.09	29.5	.86	26.4	32.6	1.19	1.29	29.7	1.5
3	8	G	17.7	32.1	1.97	32.1	1.02	36.6	1.09	27.7	.88	24.9	32.1	1.35	1.88	29.2	2.4
11	8	Av.	21.8	30.2	1.49	32.9	1.09	36.9	1 09	29.0	.86	26.0	32.5	1.26	1.45	29.6	1.8
1	9	B	17.7	45.0	2.75	44.4	2.19	46.6	1.06	47.7	1.02	31.6	47.1	1.88	3.61	39 6	8.1
4	9	G	19.9	26.6	1.49	35.5	1.23	26.6	.85	25 8	1.10	24.1	26.2	1.15	1.36	26.3	1.6
7	9	Av.	19.0	33.9	1.99	39.9	1.71	35 2	.94	35.2	1.06	27.7	35.2	1.32	2.32	32 0	4 5
4	10	B	44.9	50.0	1.04	49.9	.98	52.5	1.15	51 6	1.02	45 6	52.0	1.14	1.15	48.7	2.6
3	10	G	31.1	48.8	1.62	51.5	1.03	46.6	.97	37 7	.80	39 9	42 1	1.13	1.38	42.8	1 6
7	10	Av.	39 0	49.4	1.33	50.7	1.00	49 9	1.07	45.7	93	43 3	47.8	1.14	1.25	46.0	2 1
3	11	B	32.2	32.2	1.01	36.6	1.19	45 5	1 23	33.3	.75	32.1	39.4	1.19	1 02	35.9	1 1
8	11	G	38.7	41.6	1.12	39.9	.98	45.8	1.23	37 6	.98	40.1	42.4	1.06	1.04	41.1	.7
11	11	Av.	36.9	39.0	1.09	39.0	1.04	45.7	1.23	36.3	.91	37.8	41.6	1.09	1 03	39.7	8
5	12	B	41.4	44.6	1.34	43.3	1 00	48.3	.99	51.9	1.24	43.0	48.6	1.13	1.41	45 1	2 7
1	12	G	39.9	44.4	1.28	38.8	.87	53 3	1 41	51.1	.98	42.1	52.2	1.26	1.64	45 4	2 8
6	12	Av.	40.8	44.5	1.32	41.6	.95	50 4	1 17	51.6	1.14	42.6	49.9	1 18	1.50	45.2	2.7
4	13	B	39.1	48.8	1.23	54.9	1 07	49 9	.89	43.3	94	45 7	46.6	1 01	1.24	47 1	1.1
3	13	G	48 3	43.3	.84	46.6	1 23	56 6	1 27	51 6	90	45.7	54.1	1 21	1.03	49.2	.8
6	13	Av.	42.2	46.6	1.07	52.2	1 13	52.1	1.02	46.0	.93	45.7	49.1	1.08	1.17	47 8	1.0
4	14	B	43.2	49.9	1.43	44.9	.91	51 0	1.06	36.6	1 11	46 5	44.7	1.01	1 45	46 2	1.2
7	14	G	42.5	47.1	1.15	45.3	1 09	42 8	.82	50 4	1.36	44.9	46 6	1 06	1 28	46.2	2 0
11	14	Av.	42.9	48.1	1.25	45.1	1.01	45.3	.89	46.3	1.29	45.5	47.6	1.07	1 33	45 3	1.7
2	15	B	55.0	70.0	1.32	....	.	76.6	1.10	66 6	.87	62.5	71 6	1 17	1.29	67.0	3 8
7	15	G	43.3	51.6	1.20	48.3	93	65.0	1.34	48.3	.74	47.4	56.6	1 19	1 12	51.2	1.2
9	15	Av.	49.1	60.8	1.26	48.3	93	70.8	1 22	57.4	.80	54 9	64.1	1 18	1.20	59.1	2 3
1	16	B	56.6	46.6	.82	....	....	40.0	.86	50.0	1.25	51.6	45.0	.87	.88	48.3	—2.2
3	16	G	41.1	36.6	1.18	53.5	1.31	49.9	.93	51.0	1.02	42.7	50.5	1.56	1.37	47.5	4.6
4	16	Av.	44.9	39.9	1 06	53.3	1.31	47 4	.91	50 8	1 08	44.9	49.1	1.38	1.25	47.7	3 0
1	17	B	66.6	46.6	.69	60.0	1.28	73.3	1.22	63.3	.86	56.6	68.3	1.20	.95	61.9	— .8
2	17	G	43.3	36.6	.78	38.3	1.00	48.3	1.26	48 3	.99	40.8	48.2	1 18	1.12	43 8	1 4
3	17	Av.	51.0	41.6	.73	45.5	1 09	56 6	1 24	53.3	.94	46.0	54.9	1.18	1.06	49.8	.6
Ave. B			36.4	41.9	1.31	42.2	1.18	47 9	1 07	42.1	96	39.0	44.9	1.16	1.43	42 0	1.8
Ave. G			36.0	41.4	1.27	41.2	1 05	45 1	1 11	41 7	1.01	38 5	43.4	1.19	1.30	41.2	1.8
Ave. B & G			36.2	41.6	1.29	42.0	1.11	46.4	1.09	41 9	99	38.8	44 0	1.18	1.36	41 6	1.8

TABLE 5

Immediate Reproduction of Memorized Three-Place Digits: A1—A5

EPILEPTICS

Su.	Ae.	Sx.	1/%	2/%	f 2/1	3/%	f 3/2	4/%	f 4/3	5/%	f 5/4	1-2/%	4-5/%	f 4-5/1-2	f 5/1	1-5/%	Gain Ave. 1-5/%
81	10	B	16.6					26.6	1 60	16.6	.62	16.6	21.6	1.30	1.00	19.[illegible]	0
102	10	G	39 9	40.0	1.02	26 6	.66	30.0	1.12	30.0	1.00	39.9	30.0	.75	.75	[illegible] 3	-2 4
104	10	G	13 2	6.6	.50	23.3	3.53	20.0	.85	26.6	1.33	9 9	23 3	2.35	1.01	17.9	3.3
	Av.	G	26.5	23.3	.76	24.9	2.09	25.0	.98	28.3	1.16	24 [illegible]	26.6	1.55	1.38	25.6	.4
99	11	G	39.8	16.6	.41	46.6	2.80			20.0	43	28 2	33.[illegible]	1.18	.50	30.7	-6.6
79	12	B	13.3	30.0	2.25	36.6	1 22	23.3	63	33 3	1.42	21.[illegible]	28.[illegible]	1 31	2.50	27.3	5.0
84	12	B	23.3	43.3	1.85	30.0	.69	33.3	1.11	23.3	.[illegible]	33 [illegible]	28.[illegible]	.84	1.00	30 6	0
91	12	B	26 6	40.0	1.50	36.6	.91	43.[illegible]	1.18	50.0	1.15	33.3	46.[illegible]	1.39	1.87	[illegible].[illegible]	5.8
	Av.	B	21 0	37 7	2.80	34 4	.94	33.[illegible]	.97	35.5	1.08	29 4	34.4	1.18	1.79	32.[illegible]	3.6
108	12	G	16.6	6.6	.39	20 0	3.03	20.0	1.00	23.3	1 16	11 6	21.[illegible]	1.86	1.40	17 [illegible]	1 6
93	13	B	20.0	36.6	1.83	13.3	.36	23.3	1 75	26.6	1 14	28.[illegible]	24 [illegible]	.87	1 33	23.[illegible]	1.6
86	13	B	26.6	16.6	.62	29.9	1.80	35 3	1.11	10.0	.30	21.6	21.6	1.00	.37	23.2	-4 1
	Av.	B	23.3	26.6	1.22	21.6	1.08	28.[illegible]	1.43	18.3	.72	24.[illegible]	23.2	.93	.[illegible]5	23 5	-1 2
97	13	G	23.1	20 0	.86	20.0	1 00			30.0	1.50	21 5	25 0	1 16	1.29	23.2	2.3
77	14	B	33.2	20.0	.60	30.0	1.50	30.0	1.00	26 6	.88	26 6	28.[illegible]	1.0[illegible]	.80	27 9	-1.4
89	14	B	43.3	40 0	.92	43.2	1 08	46.[illegible]	1 07	23.3	.50	41.6	34.[illegible]	.83	.53	[illegible] 2	-5 0
	Av	B	38 2	30 0	.76	36.6	1.29	38.3	1.03	24.9	.69	34.1	31 6	.94	.66	33.5	-3.3
80	15	B	23 3	16.6	.71	30.0	1 80	13.3	.44	50 0	3.75	19.[illegible]	31.[illegible]	1.58	2.14	26.[illegible]	6 7
82	15	B	36.6	36.6	1.00	33.3	.90	33.[illegible]	1 00	33.3	1.00	36 6	33 3	.90	.90	34.6	- 8
83	15	B	3 .0	20.0	.66	23 3	1.16	10.0	.42	26 6	2 66	25.0	18.3	.73	.[illegible]8	21.[illegible]	- .8
	Av.	B	29.9	24.0	.79	28.8	1.28	18.[illegible]	.62	36.6	2.47	27 1	27.7	1.07	1.30	27.7	1.6
103	15	G	20.0	0.	.0	13.3		36.6	2 75	30 0	.82	10.0	33.3	3.33	1.50	19.9	2.5
78	16	B	10 0	13.3	1.33	20.0	1.50	30 0	1.45	30.0	1.00	11.6	30 [illegible]	[illegible].61	3.00	20.6	5.0
88	16	B	20.0	40 0	2.[illegible]0	40.0	1 00	40 0	1.00	30 0	75	30.0	35.0	1.16	1 50	34.0	2.5
85	16	B	20.0	36.6	1.83	30.0	.81	53.[illegible]	1 77	30 0	.56	28.3	41 6	1.46	1 50	33.9	2 5
	Av.	B	16 6	29.9	1 72	30.0	1.10	41.1	1 40	30.0	77	23.3	35.5	1 74	2.00	29 5	3.3
96	16	G	10.0	10.0	1 00	20.0	2.00	10 0	50	16.6	1.66	10 0	13.3	1.33	1.66	13.3	1.6
98	16	G	40.2			46 6	1.15	36 6	78	56.6	1 54	43.4	46.6	1 15	1.40	45.0	5.4
106	16	G	23 3	23.3	1.00	23 3	1.00	20.0	.85	33.3	1.06	23 [illegible]	26.[illegible]	1.14	1.42	24.6	2.5
100	16	G	9.9	33.3	3.36	33 3	1.00	26 6	79	40.0	1 50	21.6	33.3	1.54	4.04	28.6	7.5
	Av.	G	20.8	22.2	1.78	30.8	1.28	23.3	.73	36.6	1.44	21 4	29.9	1.29	2.13	27.8	4.2
87	17	B	46 6	26.6	57	43.2	1.62	10.0	.23	30.0	3.00	36 6	20 0	.54	.64	31.2	-4.1
90	17	B	10.0	0	.0	30.0		20.0	.66	30.0	1 50	5.0	25.0	5.00	3 06	18.0	5.0
	Av	B	28.3	13.3	.28	36.6	1.62	15.0	.44	30.0	2.25	20.8	22 5	2.77	1.82	24.[illegible]	4
95	17	G	0.	0	.0	0.		10 0		0.	0	0.	5.0			2.0	.[illegible]
105	18	G	23.2	20 0	.86	30.0	1 45	20.0	66	23.3	1.16	21.6	21 6	1.00	1.00	23 [illegible]	.02
107	21	G	29.8	36 6	1.22	23.3	63	20.0	.85	43.3	2 16	33 2	31 6	.95	1 45	30.6	3 3
101	24	G	13.3	6 6	.49	20.0	3 03	16 6	.83	26.6	1 60	9.9	21 6	[illegible].18	2 00	16.6	3.3
Ave. B			24.9	27.7	1 17	31 2	1.16	29 3	1.02	29.3	1.[illegible]0	26 3	29.3	1.41	1.43	28 5	1.1
Ave. G			21.5	16.9	.92	24.7	1.77	22.2	.99	28 5	1.20	19.3	25.6	1.54	1 57	22 [illegible]	1.8
Ave. B & G.			23.3	22.7	1 06	28.2	1 44	26.2	1.01	28.9	1.26	23.0	27.6	1.46	1 49	25 9	1.4

For explanation of all the tables see pages 17 to 21.

5. RESULTS (See Tables 4 and 5)

IMMEDIATE RECALL

Most of our comparisons in this and the succeeding sections will be based on the figures for the two sexes at the bottom of the tables, which give the general averages for all ages, and on the figures in the next to the last column ($\frac{1-5}{\%}$), which give the averages for all five sittings. The figures used in discussing the comparative progress will be based on these averages, unless otherwise stated, which yield the most reliable figures since they are based on all the subjects in each group and on all the sittings.

COMPARATIVE EFFICIENCY

The average efficiency per subject based on all the five tests for all the normals[1] was 41.6%, and for the epileptics 25.9%. The epileptic group showed only 62% of normal capacity. The average for the epileptics is less than the average for the youngest normal children who were tested.

The average, based on all the five sittings and all the members of the groups, is higher for the boys than for the girls among both normals and epileptics, but the difference is very small among the normals. The girls' capacity amounts to 98% of the boys among the normals as against 80% among the epileptics.[2] The boys' superiority, based on the averages for the entire group, is manifest in all the sittings among both the normals and the epileptics. Based on the general averages for the five sittings, the normal boys are superior to the normal girls in five ages, inferior in five, while the averages are equal in one age. Among the epileptics the boys are superior to the girls in 5 ages, inferior in one age, while no comparisons are possible in the remaining ages. It should be remembered, however, that comparisons between the two sexes in the different ages, in all the tests, must be merely tentative, because of the fewness of the subjects in the different ages.

The performance in this test among the normals tends to improve with increasing age, but the improvement is subject to considerable fluctuation. Thus while the scores in the two highest ages (47.7% and 49.8%) are emphatically higher than in the two lowest ages (30.8% and 29.6%, averages for the five sittings), there is an increase from age to age in only six ages, while in four ages there is an actual loss (comparing the score in a given age with the score in the next preceding age). These losses can be accounted for—we shall see that they occur in the other tests also—by two circumstances. First, the limited number of subjects tested in each age would necessarily cause irregularities in the age curve. Second, a preponderance of dull or average pupils or a lack of bright pupils in any age would tend to lower the score in that age. As already stated, we tried to secure an equal number of dull, average and bright pupils in each grade, but did not entirely succeed in this attempt. Worse still, some pupils dropped out or had to be dropped, and this created a still greater disproportion in the relative number of bright, average and dull pupils in some grades. Moreover, the pupils in the different grades were not always of the same age. When rearranged into age groups inequalities likewise arose in the number of dull, average and bright pupils in each age. The actual distribution of dull, average and bright pupils in each age is given in Table 5a. As we have already explained, the classification of the pupils was made by the school staff.

In this test the losses occur in ages 8, 11, 14, and 16, while the score is also low in age 17. It will be observed that 72% of the 8-year-olds are classi-

[1]For the sake of brevity we shall use the word "normals" for the normal children.
[2]The figures on which these and similar comparisons are based may be found in the tables.

TABLE 5a

Number of Dull, Average and Bright Pupils among the Normal Children in each Chronological Age.

	Boys	Girls	Both
Age 7—			
Dull	1	0	1
Average	1	0	1
Bright	0	2	2
Total	2	2	4
Age 8—			
Dull	1	1	2
Average	5	1	6
Bright	2	1	3
Total	8	3	11
Age 9—			
Dull	1	1	2
Average	1	1	2
Bright	1	2	3
Total	3	4	7
Age 10—			
Dull	0	1	1
Average	2	1	3
Bright	2	1	3
Total	4	3	7
Age 11—			
Dull	2	2	4
Average	1	3	4
Bright	0	3	3
Total	3	8	11
Age 12—			
Dull	1	2	3
Average	2	0	2
Bright	2	1	3
Total	5	3	8
Age 13—			
Dull	0	0	0
Average	2	1	3
Bright	2	1	3
Total	4	2	6
Age 14—			
Dull	2	2	4
Average	0	3	3
Bright	2	2	4
Total	4	7	11
Age 15—			
Dull	0	0	0
Average	1	0	1
Bright	1	2	3
Total	2	2	4
Age 16—			
Dull	1	0	1
Average	0	2	2
Bright	0	1	1
Total	1	3	4
Age 17—			
Dull	0	1	1
Average	1	1	2
Bright	0	0	0
Total	1	2	3

fied as dull or average, compared with 50% for the 7-year-olds. Only 57% of the 10-year-olds are classified as dull and average (most of these being average), while 72% of the 11-year-olds are so classified (half of these being dull. In age 14, 63% were classified as average and dull, most of these being dull, while only one-half of the 13-year-olds were classed as average and none as dull. In age 16, 75%—and in age 17, 100%—were classed as dull and average, while in age 15 no one was classed as dull, while 75% were classed as bright. The best record was made by the 15-year-olds. From these figures it would seem that the plateaus or depressions in the age curves are accounted for, in part at least, by a preponderance of dull or average children, or a lack of bright children in the ages which show losses.

As was to be expected, there is no consistent gain with increasing chronological age among the epileptics. The scores are about the same for the older as for the younger epileptics. Had the data for the epileptics been classified according to mental (Binet-Simon) instead of chronological age, we would probably have found an increasing degree of efficiency with ascending Binet-Simon age. Owing to the lack of time we did not find it possible to retabulate the data according to mental age. This can be done, however, from the data supplied in the various tables. Table 2 gives the Binet-Simon age for each epileptic.

The highest score is made by the normals in the fourth sitting and by the epileptics in the fifth, and the lowest score is made in the first sitting by the normals and in the second sitting by the epileptics.

Not a single pupil among the normals failed completely in any sitting. Two epileptics, Nos. 90 and 103, failed in one sitting each, namely in the second, while one epileptic, No. 95, made no score in four sittings. No. 103 had had a convulsion 10 minutes before the test in which she failed, and made no effort to do anything, while No. 90 was stupid in the second sitting, and made little effort, particularly in E, G and J. No. 95 had two convulsions during the night preceding the second sitting. She suffers from post-convulsive stupor, and made little effort.

COMPARATIVE IMPROVEMENT

The average monthly gain (the final column in the tables) for each of the normal subjects amounted, in absolute units, to only 1.8% and for the epileptics only 1.4%. The epileptics improved 77% as much as the normals. It should be remembered that this figure is based upon absolute units. Comparatively, the epileptics did better than this since the absolute size of the score was smaller for the epileptics than for the normals. This may be shown by basing the improvement on the indices (f). When the comparison is based on the indices of improvement, which show the percentage of improvement made by the normals in terms of their own scores made in earlier

sittings, and similarly for the epileptics, the results are as follows: The gain in the fifth sitting compared with the first ($f\frac{5}{1}$) amounted to 36% for the normals and 49% for the epileptics, a difference of 13% in favor of the epileptics. The gain, based on the comparison of the average for the last two sittings with the average for the first two ($f\frac{4-5}{1-2}$) amounts to 18% for the normals and 46% for the epileptics, a difference of 28% in favor of the epileptics. The following are the percentages of improvement made in each of the sittings when the records are compared with the scores made in the next preceding sitting:

Sitting	2d	3d	4th	5th
Normals	29%	11%	9%	−1%
Epileptics	6%	44%	1%	26%

The epileptics' gain was 23% greater than the normals' in the second sitting, 33% greater in the third sitting, 27% greater in the fifth and 8% less in the fourth. The greatest improvement by the normals was made in the second sitting, and by the epileptics in the third sitting. The relative amount of gain made by the normals steadily decreased from sitting to sitting. In fact, there was a slight loss in the fifth sitting compared with the fourth. On the other hand, the gains made by the epileptics were very irregular, very large gains being made in the third and fifth sittings and only small gains in the second and fourth sittings. An examination of the individual records in Table 5 will show that the fluctuation is large for a considerable number of the epileptics. This was to be expected. The mental capacity of epileptics subject to periodical attacks varies greatly from day to day. On some days they can accomplish a considerable amount of work, while on other days they can do very little. Based on the average monthly gain for all the sittings (last column), eight of the epileptics lost while three made no gain, or 36% of all the epileptics, while the corresponding figures for the normals are 20 and 6, or 34% of all the normals. (As we have already explained the individual records for the normals are not published here.)

The absolute average monthly gain for the normal boys was just the same as for the normal girls, but it was 61% greater for the epileptic girls than for the epileptic boys (1.8% vs. 1.1%). Based on the indices of improvement, the normal boys gained more than the normal girls in three of the indices, and less in three, while the same result obtains among the epileptics. The gain in the fifth sitting compared with the first ($f\frac{5}{1}$) was 13% greater for the normal boys than for the normal girls (43% vs. 30%), while the gain for the epileptic girls was 14% greater than for the epileptic boys (57% vs. 43%). The gain based on the last two sittings compared with the first two ($f\frac{4-5}{1-2}$) was 3% greater for the normal girls than for the normal boys (19%

vs. 16%) and 13% greater for the epileptic girls than for the epileptic boys (54% vs. 41%). The comparative data for the boys and girls of different ages can be obtained from the tables.

Based on the average gain in all five tests, last column, and the index of $\frac{1-5}{1-2}$, there is no clearly defined relation between the amount of the improvement and the age of the children. In half of the ages for the normal children the improvement grows larger with ascending age, while in half of the ages it grows smaller, when the score in each age is compared with the score in the next preceding age. If any correlation exists it is obscured by the limited number of cases in each age. We should not expect to find any constant correlation among the epileptics, and none is found, owing to the varying degrees of mental arrest found among these subjects of different ages.

SUCCESS WITH FIGURES CONTAINING IDENTICAL DIGITS AND INITIAL CIPHERS

We have made a separate tabulation in Tables 6 and 7 of the results for the figures in which all the digits were the same and for the figures which began with a zero, each card containing one each of these figures. It will be somewhat difficult to compare directly the scores made in Tables 6 and 7 with the scores made in Tables 4 and 5, because the scores made in the latter tables are based on all the ten figures, including those with identical digits and initial ciphers, while the scores in each column of Tables 6 and 7 are based only on one figure.

TABLE 6

Percentage of Pupils having Entirely Correct (all three Digits Correct) the following Special Combinations in the Digits Memory Test: A1—5.

NORMAL CHILDREN

Grade	January		February		March		April		May	
	555 %	037 %	999 %	057 %	666 %	043 %	333 %	098 %	111 %	064 %
II	33.3	0	66.6	50.	83.3	0	66.6	0	100.	16.6
III	87.5	37.5	62.5	25.	75.	50.	25.	87.5	87.5	25.
IV	88.8	22.2	100.	55.5	100.	55.5	100.	55.5	66.6	44.4
V	90.9	54.5	81.5	72.7	81.8	36.3	72.7	54.5	100.	45.4
VI	66.6	77.7	88.8	88.8	100.	66.6	100.	100.	88.8	77.7
VII	75.	66.6	91.6	91.6	66.6	50.	83.3	83.3	91.6	58.3
VIII	71.4	42.8	57.1	42.8	100.	28.5	57.1	71.4	100.	71.4
First High	75.	75.	75.	75.	50.	50.	75.	75.	100.	50.
Second High	100.	50.	100.	75.	75.	25.	75.	75.	100.	75.
Third High	83.3	83.3	83.3	66.6	50.	0	100.	83.3	100.	66.6
Average	77.6	51.3	81.5	65.7	80.2	39.4	76.3	69.7	92.1	52.6

TABLE 7

Percentage of Pupils having Entirely Correct (All three Digits Correct) the following Special Combinations in the Digits Memory Test: A1—5.

EPILEPTICS

B.-S. Age	January		February		March		April		May	
	555 %	037 %	999 %	057 %	666 %	043 %	333 %	[illegible] %	111 %	046 %
8	20.	0	20.	0	60.	0	40.	20.	60	0
9	20	20.	40.	40.	100	40	20	40.	60	40.
10	47	11.8	41.1	23 5	88.2	11 8	35.3	35 3	100	11 8
11	100	0	100	66	100	100	100.	33 3	100.	33 3
Average	43.3	10.	43.3	26.6	86.6	23.3	40.	33.3	86.6	16.6

We have computed the results in Tables 6 and 7 in terms of the percentage of pupils in each grade or each Binet-Simon age who made perfect reproductions, i. e., had all three digits of each figure correct. These percentages, however, can be readily converted into percentage scores which are directly comparable with the percentage scores in Tables 4 and 5. Thus the score 36.2, which is the general average for the first sitting in Table 4, indicates that the pupils scored 36.2% of a possible score of 100%, since the score is based on 10 figures for the complete reproduction of each of which 10% was allowed. On the other hand, the score 77.6% at the bottom of the 555 column in Table 6, indicates that 77.6% of the pupils reproduced the figure correctly and, accordingly, that the average score was 7.76%, for if we divide 77.6% by 10 (since the results are based on only one figure of the value of 10%) we obtain 7.76% as the average score for 555. But 7.76% is 77.6% of 10%, which represents a perfect score for one figure. We shall note only a few of the more important results.

The scores for the figures in which all the digits were the same (Tables 6 and 7) are emphatically higher in every case among both the normals and the epileptics than the scores based on all the figures in the corresponding sittings. Thus, the average score for 555 is 2.1 times higher for the normals and 1.8 times higher for the epileptics than the average scores for the normals and epileptics, respectively, in sitting 1 of Tables 4 and 5; for 999 the figures are 1.9 higher for both the normals and the epileptics than the average scores in sitting 2; for 666, 1.9 and 3. higher, respectively, than the scores in sitting 3; for 333, 1.6 and 1.5 higher, respectively, than in sitting 4; for 111, 2.2 and 2.9 higher, respectively, than the scores in sitting 5.

When the scores are based only on the figures with identical digits the normals did relatively somewhat better than the epileptics (when compared, of course, with the records in Tables 4 and 5) in the first and fourth sittings, the epileptics did noticeably better than the normals in the third and fifth

sittings, while there is no difference in the second sitting. The epileptics on the whole do better relatively to the normals when rated by these figures than when rated by all the figures. In fact, the absolute score for 666 was 6.4% higher for the epileptics than for the normals. In all the other sittings, however, the normals did better, the difference for 555 amounting to 34.3%; for 999, 38.2%; for 333, 36.3%; and for 111, 5.5%.

The separate tabulation of the results for these figures—and the figures for the initial ciphers—was made primarily to determine whether the improvement from sitting to sitting might not be explained by a possible tendency on the part of the subjects after the second trial to expect these figures and thus make a special effort to impress them on their memories. But this does not appear clearly to be the case. The normals made their highest score for the identical digits in the fifth sitting, and the lowest score in the fourth sitting, while they made their highest score in Table 4 in the fourth sitting and the lowest score in the first sitting. The epileptics made their highest scores for the identical digits in the third and fifth sittings and the lowest score in the fourth sitting, while in Table 5 the highest score was made in the fifth sitting and the lowest in the second.

When we turn to the figures with the initial cipher we find a somewhat different situation. The average scores are higher than the corresponding average scores for all the figures in Tables 4 and 5 in four sittings for the normals and two for the epileptics, while they are lower for the normals in one sitting and for the epileptics in three sittings. The average score for 037 is 1.4 times higher for the normals, but less than one-half as large for the epileptics as the average scores for all the figures for the normals and epileptics, respectively, in sitting 1 of Tables 4 and 5; for 057 the figures are 1.5 and 1.1 higher for the normals and epileptics, respectively, than for all the figures in sitting 2; for 043 they are .93 and .82, as large for the normals and epileptics, respectively, as for all the figures in sitting 3; for 098 they are 1.5 and 1.2 higher, respectively, than the per cents for all the figures in sitting 4; and for 064 they are 1.2 higher for the normals and a little over one-half as large for the epileptics as the per cents for all the figures in sitting 5. It was thought that the pupils would be more likely to retain these figures than any others except those with identical digits, because of the unusual character of the initial digit (factor of primacy), but this appears not to have been the case except for the normal pupils. The epileptics were less aided by this arrangement than the normals.

It is evident, therefore, when we compare the scores in Tables 4 and 5 with the scores in Tables 6 and 7, that there is no evidence that the average gain from sitting to sitting (based on the ten figures) was increased by a growing tendency to pay special attention to or specially to memorize the identical figures or the figures containing initial ciphers.

PERCENTAGE OF EFFICIENCY BASED ON THE FIGURES IN WHICH ALL THREE OF THE DIGITS WERE CORRECTLY REPRODUCED

In view of the fact that our scores are the result of summating total and partial credits—total credits being given when all three digits were correctly recalled and partial credits when only one or two digits of a figure were correctly reproduced—it seems desirable to ascertain how large the scores are when the scoring is based only on the figures which were recalled entirely correct. Tables 8 and 9 give the average percentages of efficiency when the scoring is based only on the figures in which all three digits were correctly recalled.

TABLE 8

Percentage of Efficiency when based only on the Total Number of Figures in which all Three Digits were Recalled Correctly.

NORMAL CHILDREN

Grade	January		February		March		April		May	
	Tot.[1]	%[2]	Tot.[1]	%[2]	Tot.[1]	%[2]	Tot.[1]	%[2]	Tot.[1]	%[2]
II	4	6.6	9	15 0	8	16.0	10	16.6	13	23.3
III	13	16.2	9	15 0	18	22.5	20	25.0	18	22.5
IV	20	22.2	26	28.8	31	34 4	32	35.5	28	31.1
V	28	25 4	30	30.0	29	29.0	36	36 0	37	33.6
VI	28	31 1	34	42 5	39	43 3	36	45.0	29	41.4
VII	41	34.1	47	39.1	34	30.9	51	46.3	44	40.0
VIII	24	34.2	15	30 0	30	42.8	26	37.1	26	37 1
First High	11	27.5	11	27.5	12	30.0	14	35.0	13	32.5
Second High	15	37.5	20	50 0	9	22.5	22	55.0	20	50.0
Third High	22	36.6	21	42.4	11	27.5	28	46.6	26	43.3
Total	206	27.1	222	31.7	221	31.1	275	37.6	254	34.7

[1]Total number of figures in which all three digits were correctly recalled.

[2]Average per cent of efficiency.

TABLE 9

Percentage of Efficiency when based on the Total Number of Figures in which all Three Digits were correctly Recalled.

EPILEPTICS

Subject	Age	Sex	January Total	%	February Total	%	March Total	%	April Total	%	May Total	%
81	10	B	1		..		....		2		1	
102	10	G	3		3		2		3		2	
104	10	G	0		0		2		2		2	
99	11	G	1		0		4				1	
79	12	B	1		3		3		2		2	
84	12	B	1		4		3		2		2	
91	12	B	..		4		3		4		4	
108	12	G	1		0		2		1		2	
93	13	B	0		1		1		2		1	
80	13	B	....		1		2		3		1	
97	13	G	1		2		1				...	
77	14	B	1		2		2		2		2	
89	14	B	4		3		3		3		1	
90	15	B	2		1		3		1		5	
82	15	B	2		3		3		3		2	
83	15	B	3		2		2		1		2	
103	15	G	2		0		0		3		2	
78	16	B	0		1		1		3		3	
88	16	B	1		4		4		4		3	
85	16	B	0		2		2		4		2	
96	16	G	1		1		2		1		1	
98	16	G	3		0		4		2		4	
106	16	G	2		2		2		1		2	
100	16	G	0		2		3		0		2	
87	17	B	4		2		3		1		2	
90	17	B	1		0		3		2		3	
95	17	G	0		0		0		1		0	
105	18	G	1		0		2		2		2	
107	21	G	1		3		1		2		3	
101	24	G	1		0		1		1		2	
Total ..... B			21	15.0	33	22.0	38	25 3	39	24.3	36	22 5
Total ..... G			18	12.8	13	9.2	26	18.5	19	15.8	25	19.2
Total ..... B & G			39	13.9	46	15.8	64	22.0	58	20.7	61	21.0

It is obvious from these tables that most of the credits made by both the normals and the epileptics were earned from the figures all three of whose digits were correctly reproduced. The efficiency of the normals in Table 8 compared with their efficiency in Table 4, sitting for sitting, amounts to the following: in the first sitting, 74.5% (i. e., they were 74.5% as efficient in Table 8 as in Table 4); in the second sitting, 76.2%; in the third, 74%; in the fourth, 81%; and in the fifth, 82.8%. The corresponding figures for the epileptics—i. e., the efficiency in Table 9 compared with Table 5—are as follows: first sitting, 59.6%; second sitting, 69.6%; third sitting, 78%; fourth sitting, 79%; and fifth sitting 72.6%. It must be remembered that it was relatively easy to score perfect on one of the figures, since one of the figures contained three identical digits. But the efficiency in Tables 8 and 9 is very high relative to the efficiency in Tables 4 and 5, particularly in view of the fact that the scores from the perfectly reproduced figures are also contained in Tables 4 and 5. Relatively both the normals and the epileptics (with one

exception each) gained from sitting to sitting in their ability to reproduce whole figures correctly. Relatively the normal children reproduced more whole figures than did the epileptics. That is to say, they scored relatively higher than the epileptics when the scoring was based only on the total credits than when it was based on the combined total and partial credits.

DEFERRED RECALL (RETENTIVENESS)

At the beginning of the March sitting the subjects were tested with respect to their retentiveness of the figures which they had tried to memorize one month earlier (A2). The figures, of course were not exposed again, nor had they been accessible during the month to any of the subjects. No information was given during the second sitting, or at any time, that such a test as this would be given. The time allowed for writing the figures was the same as in the original test. The results are given in Table 10.

TABLE 10

Retention During March Test of Digits Memorized in February: A 2:

Normal Children					Epileptics				
No.	Age	Sex	%	Average Number of Figures Completely Correct	Total Number of Figures Completely Correct	Subject	Age	Sex	%	Total Number of Figures Completely Correct
2	7	Boy	11 6	.5	1	81	10	Boy	0.	0
2	7	Girl	6.6	.0	0	102	10	Girl	0.	0
4	7	Ave.	9.9	.3	....	104	10	Girl	0.	0
8	8	Boy	5.41	.37	3	99	11	Girl	[illegible]	0
3	8	Girl	8.3	.5	1	79	12	Boy	6.6	0
11	8	Ave.	5 9	.4	..	84	12	Boy	....	
3	9	Boy	9.96	.0	0	91	12	Boy	6.6	0
4	9	Girl	6.63	.33	1	108	12	Girl	0.	0
7	9	Ave.	9.6	.2	....	93	13	Boy		....
4	10	Boy	10.0	.5	1	86	13	Boy	0.	0
3	10	Girl	11.06	.66	2	97	13	Girl	13.3	1
7	10	Ave.	10.64	.6	....	77	14	Boy	30.0	1
3	11	Boy	8.86	.66	2	89	14	Boy	0.	0
8	11	Girl	13.3	.5	4	80	15	Boy	0.	0
11	11	Ave.	12.0	.54		82	15	Boy	6.6	0
5	12	Boy	9.28	.0	0	83	15	Boy	0.	0
3	12	Girl	13.3	.66	2	103	15	Girl	0.	0
8	12	Ave.	10.8	.25	....	78	16	Boy	0.	0
4	13	Boy	12.47	.5	2	88	16	Boy	...	...
2	13	Girl	14 9	.5	1	85	16	Boy	0.	0
6	13	Ave.	13 3	.5		96	16	Girl	0.	0
4	14	Boy	7.5	.5	2	98	16	Girl	0.	0
7	14	Girl	9.96	.2	1	106	16	Girl	0.	0
11	14	Ave.	8.8	.33	....	100	16	Girl	0.	0
2	15	Boy	.0	.0	0	87	17	Boy	0.	0
2	15	Girl	15.0	.5	1	90	17	Boy	0	0
4	15	Ave.	10.0	.3	....	95	17	Girl	0.	0
1	16	Boy	.....	...		105	18	Girl	0	0
3	16	Girl	15.5	.33	1	107	21	Girl	6.6	0
4	16	Ave.	15.5	.33	...	101	24	Girl	0	0
1	17	Boy	6.6	.0	0	...	....	...	....	....
2	17	Girl	10.0	1.0	1	...	...	....	....	..
3	17	Ave.	8.3	.5	...	..	...	....	....	....
Average Boys.....			8.3	.33	11	Average Boys.....			3.7	.07
Average Girls			11.7	.45	15	Average Girls			1.4	07
Average Boys and Girls .			10.0	.39	26	Ave. Boys and Girls..			2.5	.07

The average efficiency of the normals was 10%, which is only 24% of the efficiency which they showed in the test one month before. The average efficiency of the epileptics was 2.5%, which is only 11% of the initial efficiency in the test. The epileptics showed only 25% of the normals' efficiency in the deferred reproduction as against 62% of the normals' efficiency in the immediate reproduction. In other words, the epileptics' capacity of retentiveness was, relatively, only half as good as their power of immediate recall, when measured by the normal capacity for immediate and deferred recall. The facts brought out by this test are well recognized by epileptologists and teachers of epileptics. Epileptics are exceedingly slow at "learning lessons" in school, and, what is worse, facts committed to memory and reproduced well at the time frequently cannot be retained for any length of time. We have found epileptics who made perfect scores in spelling immediately after the lesson had been studied, but who would fail on nearly all of the words after the lapse of a week. We have previously pointed out in connection with a study of the Binet scale,[1] that "epileptics suffer from a fundamental *impairment of memory*, as shown by consistent failures in all the tests of memory span (sentence and number tests), by the inability to reproduce six units from reading a short passage once, by the inability to recall their ages, and to remember and execute three simple commissions." We found that the average number of units reproduced in the Binet reading selection by epileptics ranging from VII to XIII years mentally was only 5.2.[2] Not a single one of the VI-year-olds passed the VI-year sentence memory test, only 27% of the VII-year-olds passed the 5-digit test, and only 2.2% of the IX-year-olds reproduced six memories from the reading test. The percentage of passes in most of the other tests in these ages was decidedly higher. We have, of course, tested epileptics who have had very good memories, particularly in certain directions, but our experimental findings corroborate the observed fact that the average epileptic suffers from a very weak memory. The weakness is probably due both to the low state of impressionability of the cortical neurones and to the destructive effects of repeated convulsions, which may not inappropriately be likened to "brain storms" which sweep away the traces left by earlier impressions. It happens very frequently that the work with epileptics in the schools, particularly the literary work, must be done over and over again before any very permanent impressions are left. And then the results of our efforts are not infrequently entirely, or largely, obliterated by a severe seizure. We have known epileptics who, after a severe attack, had so completely forgotten how to use tools of which they had acquired considerable mastery, that the use of the tools had to be taught all over again. But our observations seem to show that abstract or literary attainments are more easily lost than motor skills.

[1] Experimental Studies of Mental Defectives, 1912, p. 53.
[2] P. 80.

The normal girls did better in the deferred recall than the normal boys, the boys' efficiency being 71% of the girls'. In the immediate memory test, it will be recalled, the boys did a trifle better than the girls, the girls' efficiency being 98% of the boys'. Among the epileptics the boys did decidedly better in both the immediate and the deferred recall, but especially in the deferred recall, the girls' capacity in the deferred reproduction amounting to 38% of the boys' as against 80% in the immediate reproduction.

In the sixth and eleventh columns are given the number of figures which were reproduced perfectly, that is, in which all three of the digits were recalled in the right order. Only two epileptics and 26 normals reproduced any figures which were completely correct. This gives an average of only .39 of a figure for the normals, and of .07 for the epileptics. Almost needless to say, the figure most frequently completely recalled was 999. Many gave 555, which had been shown in January on the first card, A1. Other numbers on A1 were also occasionally mistakenly reproduced. Indeed, it is probable that the attempted reproduction of A1 in February would have proved more successful than the reproduction of A2 in March, owing to the tendency to confuse the numbers which appeared on A1 with the numbers which appeared on A2.

6. CONCLUSIONS

The general conclusions throughout are offered tentatively, for reasons we have already given.

1. The capacity of epileptic children for memorizing digits is distinctly less than the capacity of normal children. The epileptics were inferior to the normals both in the immediate and the deferred recall of the digits, but especially in the deferred recall. While their power of immediate recall amounted to 62% of normal capacity their power of retentiveness after the lapse of one month amounted to only 25%.

2. The normal boys were slightly superior to the normal girls in the immediate recall of memorized digits, but the girls distinctly excelled the boys in the deferred recall. In our dental squad the boys were slightly superior to the girls in the immediate recall. The epileptic boys were distinctly superior to the epileptic girls in both the immediate and deferred recall. On the whole, the difference between our normal boys and girls is not very considerable, while our epileptic boys are distinctly superior to our epileptic girls. As we have previously intimated, it may be a matter of chance that our group of epileptic girls was inferior to our group of epileptic boys, although there is some slight evidence that the females in institutions and special classes are inferior to the males.[1] According to the school's rating,

[1] J. E. Wallace Wallin. Report of the Board of Education of the City of St. Louis, 1915, p. 148. Psycho-Motor Norms for Practical Diagnosis, 1916, Chapter IV.

our group of normal girls may have been slightly superior to our group of normal boys, for while 25.6% of the girls were rated as dull compared with 24.3% of the boys, and while only 33.3% of the girls were rated as average compared with 43.2% for the boys, 41% of the girls were rated as bright compared with 32.4% of the boys. The difference in the intelligence status of the normals boys and girls, however, could not have been large.

3. The ability of the normal children in memorizing digits appears to increase slightly from age to age. The exceptions which we find may be accounted for by the fewness of the cases and the preponderance of dull and average pupils in the ages showing losses. The oldest pupils did 1.6 times as well as the youngest pupils. On the other hand, there is no consistent improvement with increasing chronological age among our epileptics. This statement applies to all of the other tests.

4. The ability to recall digits memorized under the conditions of this test, is very considerably reduced after the lapse of one month, the normal children doing only one-fourth as well in the deferred recall as in the immediate recall. Had the cardboards not contained a figure with identical digits the record in the deferred recall would have been still poorer. At the same time, the record in the deferred recall would have been better had an earlier series of numbers (A) not been shown.

5. The ability to recall figures with three identical digits is, of course, distinctly higher—at least 200% higher—among both normal and epileptic children, than the ability to recall figures with three different digits. The epileptics profit relatively somewhat more than the normals when the scoring is based exclusively on the figures with identical digits. In other words, the epileptics (as was to be expected) are relatively most inferior on the difficult combinations. The normal pupils also memorized the figures with the initial zeros somewhat better than they memorized all the figures, but not so the epileptics.

6. In absolute units the normal children gained more than the epileptics, but relatively the epileptics gained more than the normals. That is to say, the epileptics gained more on their own initial or early records than the normals gained on their earlier records. This is in accordance with expectation, for the normal pupils may be presumed to have initially functioned nearer their maximum than did the epileptics. But about one-third of the subjects made no gain or actually lost during the course of the experiment, the proportion being a trifle higher for the epileptics than for the normals.

7. The average monthly improvement during the five sittings was about the same for the normal boys as for the normal girls—in the earlier experiment with the dental squad the boys improved slightly more than the girls—while the epileptic girls improved more than the epileptic boys.

8. The amount of the improvement did not seem to vary with the chronological age of the children.

9. In order to use this type of an immediate memory test of non-sense materials (ten three-place digits visually presented during a 45-second exposure), it is necessary to base the scoring on each separate digit rather than merely on the three-place figure as a whole. When credit is given only for figures in which all three digits are correctly given, the unit of measurement is too large. Some pupils would receive zero for figures in which they would have only one or two digits correct. They would be deprived of partial credit for partially correct answers. As a matter of fact, if we disregard the figures with identical digits many pupils were unable to make a perfect score on any figure in one or more of the sittings. We have seen, however, that the efficiency when based on total or perfect credits only (Tables 8 and 9) amounted in most sittings to over 75% of the efficiency when based on the combined sums of partial and total scores (Tables 4 and 5). That this test is by no means an easy one, is indicated further by the fact that the average score for the normal children was only about 41% of the possible score. In our previous use of the test with 27 normal children, ages 10 to 16, who were receiving dental treatment, the average score for the entire series (six) was 2.7% higher, a negligible difference. The dental group did better in two ages that could be compared and our normal group in five ages. In the dental experiment, however, the sittings were distributed at longer intervals throughout a whole year.[1]

The highest score made in any one of these sets of figures by any one whom we have tested is 90%. The highest score made in this experiment was 83.3%. The highest number of figures reproduced completely correct (all three digits correct) by any one whom we have tested is eight—by the person who scored 90%. The above figures refer to the immediate recall.

The individual differences in the test are very considerable. The highest and the lowest individual scores made by the epileptics in the immediate recall are as follows: in sitting 1, 46.6% and 0; in 2, 43.3% and 0; in 3, 46.6% and 0; in 4, 53.3% and 10%; and in 5, 56.6% and 0. The individual extremes among the normals in the corresponding sittings are: 80% and 6.6%; 80% and 10%; 73.3% and 16.6%; 83.3% and 16.6%; and 80% and 10%. It should be remembered that the normal pupils differed in age from 7 to 17 years. The individual differences in each age (the difference between

[1]Dental Cosmos, 1912, p. 404f. and 545f.

the lowest and the highest scores made by the normal pupils of a given age), are as follows, based on the average figures for the five sittings (1–5):

Age	7	8	9	10	11	12	13	14	15	16	17
Difference ...	31.3	31.7	26.7	37.3	26.0	23.2	26.7	46.3	25.9	13.0	20.0

We asked two epileptic sections and one of the normal sections to express themselves on the question as to which one of the different tests given in this experiment was the most difficult one and which the easiest. Some of the subjects did not vote, because they were unable to decide. The epileptic boys were asked the question during two successive sittings, but the votes did not entirely correspond. Crossing off the A's (test E) was said to be the easiest by twelve epileptic boys, seven epileptic girls and one normal child. Reproducing the sequents in test G was declared easiest by one epileptic boy, constructing a sentence containing three supplied words (test J), and adding one-place digits (test C) by two epileptic boys each, and memorizing the figures in test A by four epileptic boys. The spontaneous association test (B) was thought to be the easiest by four normal pupils and the opposites test (D) by eleven normal pupils. Among the hardest tests were mentioned the addition test (C), by five epileptic boys, the range of observation test (F), by two epileptic boys and 11 normal children, the construction of sentences (J), by three epileptic girls, the memorizing of the figures (test A) by six epileptic girls, and the ink blot test (H) by three epileptic girls. This partial census did not indicate clearly which test was introspectively the hardest or which was the easiest.

10. In spite of the difficulties which beset the test, the improvement in the performance from age to age indicates that the test can be profitably used as one of a number of group tests for measuring intelligence or mental maturity. Used as a clinical test in individual diagnosis it would probably be better to allow the subject to use verbal instead of written responses. If so used norms should be established by clinical tests.

III. RAPIDITY OF THINKING

Spontaneous Association with Supplied Key Words: B1 to B5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

The stimulus material consisted of the printed blanks. 4 x 14 inches, each containing 30 words in 12 point type. The stimulus sheets also served as record sheets. The first three blanks are reproduced:

Book	Table	Pencil
House	Bed	Chair
Curtain	Window	Glass
Piano	Music	Singing
Horse	Dog	Cat
Hay	Grass	Potatoes
Leather	Shoes	Knife
Slate	Top	Skates
Buggy	Wagon	Automobile
Flag	Star	Moon
Rain	Hail	Storm
Winter	Summer	Spring
Apple	Orange	Peach
Cleveland	Chicago	New York
Nose	Mouth	Head
Canary	Robin	Rooster
Bread	Butter	Toast
Chalk	Blackboard	Dictionary
Carpet	Rug	Ceiling
Mountain	River	Valley
Recess	Reading	Spelling
Father	Mother	Brother
Roosevelt	Taft	Harmon
Addition	Substraction	Division
Coal	Gas	Gold
Lying	Stealing	Laziness
Ball-game	Work	Study
Sunrise	Noon	Evening
Church	School	Factory
Lungs	Stomach	Heart
B1	B2	B3

The 180 words used in the complete set (for reasons already given, only five of the sets could be used in this experiment) were selected from a very much larger preliminary list of familiar words. From this preliminary list 180 words were selected and arranged by the writer in six lists of 30 words each. The attempt was made to make each list approximately equal in total difficulty, by distributing an equal number of easy and hard words on each sheet. Practically all of the words selected were common nouns. Each sheet contains only one verb and two proper nouns, one being the name of a well-known city (except on the sixth sheet) and one the name of a well-known person (an assumption, no doubt, justified so far as concerns the group of Cleveland children who were first tested). These six lists were then submitted to three instructors in a training school for teachers, who were asked to rearrange them into six lists, each of which should represent collectively the same degree of difficulty. The final lists were based on the combined judgments of all who thus assorted the words. This method of constructing word lists of supposed equal difficulty is, of course, open to various objections. None of those who arranged the lists felt a very high degree of confidence in the correctness of his arrangement. But it is probable that the combined judgments of several persons is superior to the judgment of one person. To obtain thoroughly satisfactory lists we should probably have to test six groups of children of equal degrees of capacity, as stated in the preceding section—it was impossible to do this at the time these lists were prepared—but, even so, the difficulty of the different lists would probably vary more or less according to the varying experiences of different groups of children. The readiness of words of the same degree of familiarity to arouse associations will inevitably differ among different individuals according to their varying experiences, a condition that can scarcely be remedied. But we would emphasize that these word lists, even though they should prove not to be equally difficult, can be legitimately used for the purpose for which we are especially employing them, namely for gauging the comparative efficiency of our normal and epileptic subjects.

Our tests are somewhat marred by the inclusion of a few local words. The subjects, however, were always instructed to pass over words whose meaning they did not comprehend or words which did not suggest any words to them.

2. NATURE AND PURPOSE OF THE TEST

This is a species of "free" or spontaneous association test. It is free in the sense that the subject was permitted to write any words at all, logical or illogical (as a matter of fact, the vast majority of the words written were logically connected with the antecedent key-words), suggested by each of the

supplied key-words. The test differs from the ordinary "running" free association test, in which the subject starts with only one supplied key-word and writes or recites a series of words, each one of which is suggested by the word which has just been uttered or written. Either one of these so-called association tests may be used as a test of the speed of ideating or thinking, since thinking is essentially a process of forming connections or associations between ideas, and of expressing such associations in words. There is probably little thinking that is entirely imageless or wordless.

The number of words written in this test represents the rate of forming spontaneous associations with predetermined antecedents plus the time required to write the words. The writing time is, of course, a considerable factor. Most subjects can utter word associates very much faster than they can write them. Moreover, the writing time complicates the experimental problem, because children differ a great deal in the speed of writing who might not differ very greatly in the speed of forming associations. The younger children write much slower than the older children, while many epileptics whom we have studied and probably many backward children write much slower than normal children. The uncertainty or inability to spell the word, would serve to further retard the responses of the younger, backward and epileptic children. In order to mitigate this retarding influence the children were instructed not to linger over the spelling of words—not only in this test, but in all the tests—in order not to lose any time. Some children wrote extremely few words. It would be difficult to say without investigating each case whether this was due to inability to spell, difficulty to write, or slowness in ideating the words. A few children occasionally wrote two or three words, or a phrase of two or three words. Such responses were given only one unit of credit.

From what we have said, it is probable that had the words which suggested themselves to the subjects been expressed verbally instead of in writing the younger children and the epileptics, and possibly the backward children, would have done relatively better than they did, although it is likely that most younger, backward and epileptic children also ideate slower than normal children.

It is further evident that if some children tended to write long words and other children short words, the latter children would probably be able to write more words. Moreover, children who made the greatest progress in writing during the five months of the experiment, or who tended progressively to write shorter words would tend to show the greatest improvement in the test. If the test is to be used to measure the amount of gain made in forming associations we must assume that the writing time remains approximately constant from test to test, or that the average length of the words was the

same in the different tests. The impression gained from the examination of the successive lists seemed, in the main, to justify the latter assumption. It must be remembered, therefore, that the time in this test represents both the time to think and the time to write the suggested words, since it is impossible under the conditions of the experiment to measure independently these two variables. The necessity of giving group tests limited the reactions to written responses. In our discussion of the results the above considerations must be borne in mind.

3. DIRECTIONS FOR GIVING THE TEST

General Instructions: Follow the general instructions on page 15.

Order of Giving Tests: During the first sitting, B1, Second sitting, B2, etc.

Time: 60 seconds (one minute). Pupils sit with folded hands. Have the papers placed upside down on the desks occupied by the pupils, with the request that they must not touch them.

Instructions to be Given to the Pupils: "On the other side of the paper you will find a list of simple words. When I say 'turn' you must turn your papers at once and write opposite each word the first word that it makes you think of. You must try to write the first word that comes to your mind, whether it makes any sense or not. Don't write the same word and don't write sentences; just single words. If you come to a hard word that doesn't make you think of anything, don't stop, but go right on to the next word. Later on if there is time you can go back to this word. If you do not know how to spell a word that you want to write, spell it as well as you can so that you will not lose any time. Nothing will be counted off for words spelled wrongly. (Illustrate test on board by means of the following words. Use no others in this or later tests: Book—paper. House—wood. Curtain—window. Piano—music, or singing. Horse—drive, or animal.)

"Now, ready!" "Turn your papers!"

"Now, stop!" "Turn your papers!"

Signature: At the close of the test the pupils write at the top of the paper: full name, age, sex, date, hour, condition, school, and grade.

Grading of Papers: The ranking will be on the basis of the number of words (associates) written. Each word will be rated 3.3%. Ten per cent should be given for three associations. Find the per cent of efficiency (in decimals, not fractions). The efficiency is based on the speed and not on the quality of the associations.

4. TABLES

TABLE 11

Spontaneous Association with Supplied Key-words: B1—5

NORMAL CHILDREN

No.	Ae.	Sx	1 %	2 %	3 %	$f\frac{3}{2}$	4 %	$f\frac{4}{3}$	5 %	$f\frac{5}{4}$	2–3 %	4–5 %	$f\frac{4-5}{2-3}$	$f\frac{5}{2}$	2–5 %	Gain Ave. 2–5 %
2	7	B	21.6	15.0	21.6	1.44	20.0	.92	20.0	1.00	18.3	20.0	1.09	1.33	19.1	1.6
2	7	G	41.6	33.3	33.3	1.50	29.9	1.13	29 9	1.00	29.1	29.9	1.19	1.00	[illegible].3	2.0
4	7	Ae.	31 6	21 1	27.4	1.47	19.9	1.06	19.9	1.00	23.7	19 9	1 16	1.11	24.7	1 8
8	8	B	25.2	26 6	27.6	1.94	33.2	1.07	29 1	.89	28.3	30.1	1 02	1 57	29 [illegible]	.9
3	8	G	13 3	17 7	22.2	1.25	29.9	1.54	20 0	.67	19.9	24 9	1 43	1 28	22.4	.7
11	8	Ae.	22.0	24.2	25.9	1.73	32 2	1.21	26 6	.83	26.0	28 7	1.13	1 49	27 2	8
3	9	B	14.4	25 0	33.3	.99	32.2	1.06	33.3	1.00	33 8	32.7	1.01	1 02	32.[illegible]	.4
4	9	G	30 8	23.3	29.9	.95	25.8	.94	2[illegible] 8	1.11	24.5	23.2	[illegible]	[illegible]	23.[illegible]	— 1 8
7	9	Ae.	23.7	23.[illegible]	31.6	97	28.5	.99	26 1	1.06	28.5	27.3	95	.93	27.7	— .8
4	10	B	39.1	[illegible]8 8	38 8	1 03	45.8	1.18	45 7	1.00	38 7	45.7	1.18	1 19	43 [illegible]	2.9
3	10	G	42.2	39.9	43.3	1.22	37.7	.87	38 [illegible]	.95	41 6	38 3	[illegible]	95	39.9	— .3
7	10	Ae.	40.4	39 4	41.0	1 15	42 3	1.05	42 8	.98	39.9	42 5	1.06	1 08	41.7	1.4
3	11	B	39.9	36 6	46.6	1.32	39.9	.86	41 0	1 02	41.6	40 5	98	1.16	41.0	1.4
8	11	G	47.8	39.9	50.3	1 29	47.8	.93	46.6	1.03	45.1	48.0	1 [illegible]4	1.34	49 1	2.4
11	11	Ae.	45.7	39.0	49.3	1.30	45 7	.91	44 9	1.03	44.1	46 0	1 03	1 29	46.9	2 1
5	12	B	51.9	46.6	55.9	1.19	59.9	98	57 3	1.03	51.2	56.6	1.09	1 22	53 9	3 8
3	12	G	51 0	50.0	57.7	1 16	58.[illegible]	1.02	52 2	[illegible]	53 [illegible]	55.5	1 02	1 [illegible]	54.6	7
8	12	Ae.	51.6	47 9	56.6	1.18	59.5	1.00	55 4	.97	52.2	56 2	1 07	1 15	54 1	2.6
4	13	B	52 2	44 4	51.6	1.16	50.8	.98	55.8	1.15	48.7	53.2	1.08	1 20	50.6	3.3
2	13	G	41 6	38 3	48.3	1 27	41.6	.79	33.3	1.17	43.3	37.4	.84	.[illegible]	40 3	— 1.6
6	13	Ae.	48 7	41.9	50.5	1.21	47.7	.91	48.3	1 15	46.9	48.0	1 00	1 09	47 2	1 6
4	14	B	44 2	54 1	58 3	1 07	62 2	1.09	57 7	94	56 2	59 [illegible]	1.07	1.07	57.4	1.6
7	14	G	42 8	54.7	54.6	98	52 3	.97	56.1	1.08	53 5	54 2	1 00	1 04	54 [illegible]	[illegible]
11	14	Ae.	43.3	54.5	56.2	1.02	55 2	1.01	56 6	1.04	54.6	56.3	1.03	1.05	55.4	8
2	15	B	51.3	68 3	93 3	1.12	75.	1 04	66 6	.90	70 8	70 [illegible]	1 02	.[illegible]	71.3	[illegible]
2	15	G	50 1	63.3	68.3	1 08	74 9	1.09	69 9	.96	65.8	72.4	1 09	1 [illegible]0	79 1	2.2
4	15	Ae.	50 7	65 8	76.6	1.09	74 9	1.07	68.3	.93	68.3	71.6	1.05	1 05	75.2	1.5
1	16	B	53.4	56 6	.	....	50 0	[illegible]	53 3	1 06	56 6	51.6	.91	[illegible]	53.[illegible]	— 1 6
3	16	G	56.8	61.6	61 0	1.13	72.1	1.22	66 6	.92	58.3	69 4	1.22	1 23	[illegible].1	1 2
4	16	Ae	55.9	59 9	61.0	1.13	66.6	1 13	63 3	96	57 9	64.9	1.14	1.15	62.[illegible]	6
1	17	B	30.6	50.9	50 0	1.00	50.0	1.00	66 6	1.33	50.0	58 [illegible]	1 16	1.33	54.1	5.5
2	17	G	44 4	66 6	68.3	1.00	65 0	.95	66 6	1.03	68.3	65.8	96	.97	66 7	2.0
3	17	Ae.	39.8	58.[illegible]	62.2	1.00	60.0	.96	66.6	1 13	62.2	63 3	1.03	1 09	[illegible] 5	3.3
Ave. B. ...			37.7	39.5	44.1	1 34	45 6	1.03	44.6	1.00	41 7	45.2	1 06	1.30	[illegible].5	2.0
Ave. G.....			42.3	43.4	48.7	1 17	47.9	1.02	45 6	.99	46.1	46 [illegible]	1.04	1 10	46.[illegible]	.8
Ave. B & G.			40.1	41.4	46.5	1 25	46.9	1 02	45 2	.99	44 0	46 0	1 05	1 17	45 1	1 4

TABLE 12

Spontaneous Association with Supplied Key-Words Bl—5

EPILEPTICS

Su.	Ae.	Sx.	1 %	2 %	3 %	f 2/3	4 %	f 3/4	5 %	f 4/5	2-3 %	4-5 %	f 4-5/2-3	f 3/2	2-5 %	Gain Ave. 2-5 %
81	10	B	0	.	.		6.6		13 3	2 01		9.9		....	9.9	6.7
102	10	G	6.6	20 0	6.6	33	16.6	2 51	6.6	40	13 3	11 6	87	33	12.4	−4 4
104	10	G	27 6	40.0	30.0	.75	60.0	2.00	56.6	94	35 0	58.3	1.66	1.41	46 6	5.5
....	Av.	G	17 1	30.0	18 3	.54	38 3	2.25	31 6	67	24 1	34 9	1.26	87	29 5	.6
99	11	G	13 8	43 3	33.3	.76	....		36 6	1 10	38.3	36.6	.93	.84	37 7	−3.3
79	12	B	9.0	3.3	23 3	7 06	6.6	.28	6 6	1.00	13.3	6.6	.49	2.00	9.9	1 1
84	12	B	16 2	26.6	23 3	.87	26.6	1.14	26.6	1 00	24.9	26.6	1.06	1 00	25 8	0.
91	12	B	18.6	23.3	23 3	1.00	33.3	1.42	23.3	.69	23 3	28 3	1.21	1 00	25.8	0.
	Av.	B	14.6	17.7	23 3	2.97	22 1	.94	18.8	.89	20.5	20.5	.92	1.33	20.5	.3
108	12	G	0	0.	0.	....	0.		6 6	.	0.	3.3	3.30	. .	1.6	2 2
[illegible]	13	B	3.3	6 6	23.3	3 53	20 0	.85	20.0	1 00	15 0	20 0	1 33	3.03	17.5	4.4
86	13	B	9.0	13 3	16 6	1.24	13.3	.80	6.6	.49	15 0	10 0	.66	49	12 4	−2.2
	Av	B	6.1	9.9	19 9	2 38	16 6	82	13.3	.74	15.0	15 0	99	1.76	14.9	1.1
97	13	G	6.6	13 3	16.6	1 24	....		6.6	.40	15 0	6.6	.44	49	12 2	−3 3
77	14	B	23 4	36 6	33 3	.90	33 3	1.00	40.0	1.20	35.0	36.6	1.04	1 09	35 8	1.1
89	14	B	0.	20 0	33 3	1 66	30.0	.90	23.3	.77	26 6	26 6	1.00	1 16	26 6	1 1
	Av.	B	11 7	28.3	33.3	1.28	31 6	95	31 6	.98	28 3	31 6	1.13	1 12	31.2	1.1
80	15	B	0.	16 6	10.0	.60	20 0	2 00	10.0	.50	13 3	15.0	1 12	.60	14.1	−2 2
82	15	B	11.4	20.0	26 6	1 33	20 0	.75	26 6	1.33	23 3	23 3	1 00	1.33	23.3	2.2
[illegible]	15	B	0	10 0	10 0	1.00	6.6	.66	16 6	2 51	10 0	11.6	1 16	1 66	10 8	2.2
....	Av.	B	3.8	15 5	15.5	.97	15 5	1.13	17.7	1.44	15.5	16.6	1 09	1 19	16.0	.7
103	15	G	0	0.	6.6	....	10 0	1 51	13.3	1 33	3.3	11 6	3.51		7.5	4.4
78	16	B	0.	6 6	13 3	2.01	16.6	1.24	10.0	.60	10 0	13.3	1 33	1 51	11 6	1 1
88	16	B	16 6	23.3	13.3	.57	20 0	1.50	23.3	1.16	18 3	21.6	1 18	1.00	20 0	0.
85	16	B	9 0	16 6	30.0	1.80	20 0	.66	33.3	1 66	23.3	26 6	1.14	2.00	25 0	5.5
....	Av.	B	8.4	15 5	18.8	1.46	18.8	1.13	22.2	1 14	17 2	20.5	1.21	1.50	18.8	2.2
96	16	G	0.	0.	0		....		6 6		0.	6 6	....	..	2 2	3.3
[illegible]	16	G	9 9		13.3		13 3	1 60	6.6	.49	13 0	10 0	.75		11 1	−3 3
106	16	G	6.6	13.3	16.6	1.24	10 0	.60	6.6	.66	15 0	8.3	.55	49	11 6	−2 2
[illegible]	16	G	[illegible]	10 0	13.3	1.33	0.	0	13.0	.	11.6	6.5	56	1 30	9 1	1
	Av	G	4.1	7.7	10.8	1 28	7 7	53	8.2	.57	9.5	7.8	.87	89	8 1	− .3
87	17	B	0.	10 0	0.	.0	0	....	0	.	5.	0	0	0.	2.5	−3.3
90	17	B	0.	0.	30.0	....	0	0	0		15.	0.	.0	0.	7.5	0
	Av	B	0	5.	15.	....	0.	0	0	....	10.	0.	0	0	5.0	−1.6
95	17	G	0	0.	0	..	0	.	0.	....	0.	0	0	0	.0	0
105	18	G	6.6	0.	10.		0.	.0	13.3		5.	6.6	1.32		5.8	4.4
107	21	G	9 0	10	10.	1.00	3.3	.33	6 6	2 00	10.	5.	50	.66	7 5	−1 1
101	24	G	0	10	6.6	.66	[illegible]	0	3 3	....	8 3	1.6	.19	.33	5 0	−2 2
Ave	B.....		7.2	15 5	20.6	1.68	17 0	95	17.4	1 13	18.3	17 2	91	1 19	17 6	9
Ave.	G		6 1	12 3	11.6	.91	10.3	[illegible]	13.0	91	11 9	11.8	1.12	.65	11.8	2
Ave	B & G		6 7	14 0	16 2	1 40	14 3	92	15.3	1.05	15.5	13.1	1.01	.98	15 0	.6

5. RESULTS (See Tables 11 and 12)

The evaluation of the results in this test might be made from two points of view, first, from the standpoint of the quality of the associations, and, second, from the standpoint of the number of associations which were formed. Our discussion is limited entirely to the quantitative aspect, owing to the difficulty of making a satisfactory graded qualitative evaluation of the responses. We repeat, however, that the vast majority of the associations were of the logical type. Binet and Simon conclude from a different association test "that logic is easier to follow than chance."

COMPARATIVE EFFICIENCY

The average efficiency, based on the mean for all the subjects and for all the sittings except the first[1] (column headed 2-5 %) was 45.1% for the normals

[1]The scores made in the first sitting are not included as the time allowed during this sitting (85 sec.) was inadvertently lengthened 25 sec.

and 15.0% for the epileptics. In other words, the epileptics' efficiency amounted to only 33% of the normals. The epileptics did only a little more than one-half as well as the youngest normals tested, and not quite one-fourth as well as the oldest normals. We have previously called attention to the pronounced psychic and psycho-motor retardation affecting the reactions of epileptics.[1] This retardation appears more emphatically in the present group test than in any of the previous clinical tests which we have given, possibly due, in part at least, to the fact that the average normal child is able to write more rapidly than the epileptic child. We shall see later from test L that the speed of executing a very simple writing movement, writing circles, was slower for the epileptics than for the normals.

The boys' capacity, based on the general average at the bottom of the column for all four sittings, was slightly lower than the girls' among the normals, but considerably higher among the epileptics. The normal boys did 93% as well as the normal girls, while the epileptic girls did only 67% as well as the epileptic boys. The girls did better in every sitting among the normals and poorer in every sitting among the epileptics, based on the sex averages at the bottom of the percentage columns.

Based on the sex averages for sittings 2 to 5, the normal girls did better than the normal boys in six ages and poorer in five ages, while the epileptic girls did better than the epileptic boys in only one age and poorer in five ages, no comparative data being available in the other ages contained in the table. Thus, while the difference between our normal boys and girls is not very significant, the epileptic boys are distinctly superior to the epileptic girls. This may be due, as we have already intimated to the fact that we were dealing with a group of epileptic girls who were more than ordinarily deficient.

Considering the fewness of the subjects there is a very consistent improvement in this test from age to age among the normals. Based on the averages of the two sexes for sittings 2 to 5, there is an improvement in eight and a loss in only two ascending ages, when the score in each age is compared with the score in the next higher age. The loss occurs in age 13, in which half of the children were classed as bright, half as average, and none as dull, while in age 12, 62% were classed as dull and average;, and in age 16, in which three-fourths were classed as dull or average. The score in age 17, in which all the pupils were classed as dull or average, is practically the same as in age 16. The highest score is in age 15, in which all of the pupils were classed as bright or average, and three-fourths as bright. The difference between the averages in the lowest and in the highest age amounts to 37.8% (62.5%—24.7%). We have also found a consistent increase in the related Binet-Simon 60-word association test when epileptics are classified according to

[1]Experimental Studies of Mental Defectives, 1912, p. 106. Psycho-Motor Norms for Practical Diagnosis, 1916, p.37.

Binet-Simon age.[1] The figures for the epileptics in the present test in which the data are arranged according to chronological age, indicate that there is no consistent improvement from age to age. In fact, the records of the oldest children are considerably inferior to the records of the youngest children.

One epileptic (No. 95) failed to score at all in any sitting, three failed completely in four sittings, one in three sittings, four in two sittings, and five in one sitting. Only two or three of these failures could be directly ascribed to an earlier convulsion. One normal child failed in all the sittings (No. 5, a dull, restless, inattentive boy of seven), and two in the first sitting, an "average" boy (No. 7) of eight, and a "dull" boy (No. 43) of nine.

The normals made the highest score in the fourth sitting and the epileptics in the third, while both the normals and the epileptics made the lowest score in the first sitting.

COMPARATIVE IMPROVEMENT

The average monthly gain made by each subject from sittings 2 to 5 (last column in the tables) amounted, in absolute units, to only 1.4% for the normals and .6% for the epileptics. The epileptics improved 43% as much as the normals. Since, however, the above gains are based upon absolute units, it is to be expected that the epileptics would do relatively better when the improvement is computed as a fraction of the size of the scores which they made, because the epileptic scores were considerably smaller than those made by the normal pupils. Relatively to the size of the scores the epileptics do better, but, on the whole, do not quite equal the normals, as may be shown by comparing the various indices of improvement, which are obtained by dividing the early scores into the later scores. The gain in the fifth sitting over the second sitting ($f\frac{5}{2}$) amounted to 17% for the normals, while the epileptics suffered a loss of 2%, a difference of 19% in favor of the normals. The improvement, when based on a comparison of the average of the last two sittings with the average of the second and third ($f\frac{4+5}{2+3}$), amounts to 5% for the normals but only 1% for the epileptics, a difference of 4% in favor of the normals.

The following are the percentages of improvement made in each of the three later sittings when the record in a given sitting is compared with the record in the next preceding sitting:

Index	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$
Normals	25%	2%	–1%
Epileptics	40%	–8%	5%

The difference in favor of the epileptics amounts to 15% in the third sitting and 6% in the fifth sitting, while the difference in favor of the normal

[1] Experimental Studies of Mental Defectives, 1912, p. 78.

pupils amounts to 10% in the fourth sitting. The greatest gain was made in the third sitting by both groups. Both groups suffered loss in one sitting, the normals in the fifth and the epileptics in the fourth. The variation from sitting to sitting is greater for the epileptics. Many epileptics varied extremely from sitting to sitting both in this test and in the other tests, as may be seen by an examinaion of the tables.

Based on the average monthly absolute gain for sittings 2 to 5, nine epileptics lost and two made no improvement, which is 36% of all the epileptics, while the corresponding figures for the normal children are nineteen and six, which is 33% of the normals.

The absolute average monthly gain was about two and a half times greater for the normal boys than for the normal girls (2.% vs. .8%), and four and a half times greater for the epileptic boys than for the epileptic girls (.9% vs. .2%). Based on the average indices of improvement at the bottom of the tables, the normal boys gained more than the normal girls in all of the indices, while the epileptic boys gained more in three indices, and lost less in one than the epileptic girls, and the epileptic girls gained more in one index. The gain in the fifth sitting compared with the second ($f \frac{5}{2}$) was 16% greater for the normal boys than for the normal girls (26% vs. 10%), and 54% greater for the epileptic boys than for the girls (19% vs. a loss of 35%). The gain based on the average of the last two sittings compared with the average of the second and third ($f \frac{4-5}{2-3}$), was 2% greater for the normal boys than for the normal girls (6% vs. 4%), but 21% greater for the epileptic girls than for the epileptic boys (12% vs. a loss of 9%).

There seems to be no correlation between the amount of the improvement and the age of the children. When the average monthly gains for the normal pupils (2-5) are compared in each successive age—e. g., age 7 with age 8, 8 with 9, 9 with 10, etc.—the gains increase in half of the ascending ages and decrease in the other half. Among the epileptics the results are so irregular as to defy comparison.

We have already emphasized that our comparisons between the different ages are based on only a few subjects in each age, and the conclusions drawn must therefore be more or less tentative.

6. CONCLUSIONS

1. The ability of our normal pupils to supply written associates in this test was somewhat lower than the ability of the pupils in our dental group. The average score for the last four sittings for the normal pupils was 8.2% lower than the average score made in the complete series of six tests by the dental group. The dental group was superior in four ages and our normal group in three years where direct comparisons could be made. The superiority of the dental group may be due to the fact that the dental squad

was allowed 25 seconds more time for writing. In sitting one where the time was the same the dental group, however, is still superior, but the difference is less. The fact that 22% of our normal children were under ten, while no one in the dental group was under ten may also account for the difference. It should be stated, however, that the dental group contained a larger proportion of pupils rated as backward than the normal group used in the present experiment.

Based on the work of these two normal groups, we may conclude that while the test can be easily performed by normal seven-year-old children, the conditions under which it is given are such that young adolescents are unable to make perfect scores.

2. The speed of thinking or forming free associations, under the conditions of this test, is distinctly slower among the epileptic than among normal children, the epileptics doing only one-third as well as the normals. We have before frequently called attention to the retarded flow of thought in many epileptics, not only in their conversation but also in the free running association test given in the Binet scale. The epileptics, as a class, have been slower in their mental and motor reactions than any other class of subjects of the same intellectual status studied by us.

3. The normal girls were slightly more rapid in writing associations than the normal boys. On the other hand, in our dental squad experiment the boys did noticeably better than the girls, just as our epileptic boys did distinctly better than our epileptic girls.

4. There is a progressive increase from age to age in the speed of forming associations (or, at least, in writing word associates) among the normal children. The oldest pupils did about two and a half times as well as the youngest pupils. One of the two losses which occur is accounted for by a preponderance of dull and average children in the age concerned, while the other loss cannot be thus explained.

Binet and Simon's conclusion that "the association times are longer with normals than with imbeciles"[1] apparently finds no support from our own results, since we found that in this test (using written responses) the epileptics give less associates than the normals and the younger (or less intelligent) normals less than the older normals, while in the 60-word Binet association test (oral) the number of words given increased with increasing mental (Binet-Simon) age. Binet and Simon used oral responses to a list of thirty words. Their conclusions, however, are based on the reactions of only four feeble-minded persons.

5. Considerable individual differences obtain in the speed of association, as shown by the lowest and highest individual scores in each sitting, which

[1]Alfred Binet and Th. Simon. The Intelligence of the Feeble-Minded, 1916, p. 73.

are as follows: For the epileptics: sitting 1, 0 and 27.6%; 2, 0 and 43.3%; 3, 0 and 33.3%; 4, 0 and 60%; and 5, 0 and 56.6%. For the normals the extremes in the corresponding sittings are: 0 and 80%; 0 and 83.3%; 0 and 93.3%; 0 and 90%; and 0 and 80%. The individual differences in each age, based on the average scores for sittings 2 to 5, are as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference ...	38.3	31.6	42.2	41.7	39.1	29.5	25.8	29.2	27.2	20.0	13.6

6. The normal pupils averaged a larger improvement per month in this test than did the epileptics, both absolutely and relatively, but the superiority in the relative improvement (i. e., relative to the size of the average scores) was less marked. About one-third of the subjects made no improvement at all or actually deteriorated in the test, the proportion being slightly higher among the epileptics.

7. The average monthly improvement was clearly greater for the boys than for the girls among both the normals and the epileptics. On the other hand, in the experiment on the dental group the girls improved more than the boys.

8. There is no correlation between the age of the subjects and the amount of the improvement.

9. The ascending age curve indicates that this is a serviceable group test of intelligence. It is easy of administration. It can be given to children who differ widely in maturity and capacity. Its use, however, is restricted to children who can write; and the writing introduces a factor which considerably complicates the problem. As a clinical test it is probably better to adminster the test orally, and record the total time necessary to respond to all the words. We have not attempted to determine the value of the free association test for qualitative analysis. In this connection the frequency tables of Kent and Rosanoff, which give the frequency coefficient for many reactions to each of 100 common words, are suggestive: A Study of Association in Insanity, American Journal of Insanity, LXVII, pp. 37-96 and 317-390.

IV. ADDITION TEST

Additon of Detached Columns of 10 One-Place Digits: C1 to C5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

The blanks, 8 x 8.5 inches in size, contained 32 columns of one-place digits in 10 point type, arranged as shown in the reproduction below. The subjects made their records at the bottom of each column on the printed blanks. The numbers used in the first three blanks were arranged purely indiscriminately by drawing digits from a receptacle containing a large number of numbered tags. The numbers on the three later blanks were arranged by a systematic redistribution of the numbers on the earlier blanks. It was thought that this chance distribution of the numbers would come as near to yielding blanks of equal difficulty as a more studied procedure. But, of course, this supposition may not be justified. Some columns contain a larger number of large digits than others and some columns probably con-

2	3	3	9	4	9	3	2	9	8	7	6	7	5	6	9
5	5	7	2	2	3	7	5	4	7	9	2	5	9	2	4
8	7	3	7	3	6	8	6	4	4	6	9	2	5	7	7
8	2	8	8	2	6	5	8	7	9	4	6	7	6	5	8
7	6	2	2	9	5	3	3	6	4	9	5	5	8	2	8
7	8	6	4	5	8	2	8	5	8	7	6	8	2	9	2
2	7	9	5	8	4	8	8	9	4	5	3	6	9	8	9
9	9	3	7	7	8	3	7	4	7	9	5	4	7	4	2
6	4	6	4	5	3	9	3	4	9	8	9	8	7	2	7
9	9	8	9	5	2	8	8	8	7	6	7	3	3	7	6
63	60	55	57	50	54	56	58	60	67	70	58	55	61	52	62
2	4	9	5	8	2	9	6	3	6	7	8	4	4	5	4
9	6	9	9	2	7	3	6	9	7	5	6	8	6	7	7
6	5	8	4	8	9	3	7	8	9	9	3	3	3	9	4
3	4	6	8	9	7	8	4	7	5	2	6	9	5	2	5
7	9	9	2	4	2	4	4	3	7	5	9	6	8	4	7
2	2	8	9	6	9	2	5	2	6	3	5	2	3	8	6
9	7	6	6	2	6	6	4	3	4	4	2	4	5	3	6
6	2	3	3	7	3	9	7	4	5	8	9	9	6	9	8
3	9	2	8	9	5	5	9	7	4	9	7	2	2	8	9
8	5	6	4	5	7	6	6	9	9	9	2	8	6	2	4
55	53	66	58	60	57	55	58	55	62	61	57	35	48	57	60

C1

tain more difficult combinations than others; the sums of the different columns may vary as much as 20, although the difference is usually very much less, as may be seen by comparing the sums on the blank. (The sums, of course, did not appear on the blanks given the pupils.) And yet, even when this is so, the collective difficulty of the different blanks may be approximately the same, i. e., the average difficulty of a number of columns. There is no method, however, of demonstrating that the blanks are equal in difficulty except by the method which we have already discussed (p. 23).

2. NATURE AND PURPOSE OF THE TEST

Unlike the preceding test, this is a controlled association test. The successful performance of the test depends upon the ability to form correct or controlled associations between number concepts, and to carry in mind the results of such successive associations. In other words, we measure in this test the ability of the subject to add a series of numbers rapidly and correctly. While this may be regarded primarily as a pedagogical test, it may also be used, we believe, as a psychological test. The test possesses considerable value for a number of reasons. First, it is easy to construct appropriate test materials with the use of digits. Second, addition is perhaps the most basic of the four fundamental mathematical processes and a fundamental instrument of social control. For that reason pupils are taught to add at the beginning of their grade work. It is a test, therefore, which allows of a wide range of application to children of different ages, and which tests the pupils' degree of automatic control of a fundamental school and social tool. Third, while the ability to add depends on training and mathematical talent, it also depends, to some extent at least, on general intellectual ability, on the ability to remember successive number sums and on the ability to keep the attention fixated on the problem. The strain on the attention varies more or less directly with the length of the columns to be added. Our ten digit columns were sufficiently long to tax the attention of most of our subjects.[1] In view of the above facts, the test can be used, we believe, with reservation, as a test of intelligence. It is, however, probably a more valid test of intelligence of children of the same extent of schooling, than of adults. We recognize, of course, that some children are handicapped by deficient number imagery. The test could not be used as a valid measure of the intelligence of such children. Whether or not we are ready to grant that this is a test of intelligence is immaterial for the present research, as we shall state our results in terms of the work performed in the test. The empirical results will remain the same irrespective of the interpretation which may be placed on the trait which is measured by the test.

[1]This, however, is not an unmixed virtue, because it requires a larger unit of measurement for scoring the results. All the subjects who just failed to complete a column at the end of the test lost relatively more than they would have done had the columns been shorter. It is doubtful, however, whether a column of 10 one-place digits is too large a unit, except for the younger pupils, in a test lasting two minutes.

3. DIRECTIONS FOR GIVING THE ADDITION TEST

General Instructions: Follow directions on page 15.

Order of Giving Tests: During first sittings, C1. Second sitting, C2. Etc.

Time: 120 seconds (two minutes, precisely). Place the papers upside down on the desks used by the pupils, telling them that they must not turn them over until they are requested to do so.

Instructions to the Pupils: "On the other side of the papers which I have placed on your desks are single columns of numbers. The moment I say 'turn' you must turn the papers over without delay and begin at once to add up the columns. Begin with the first column—the upper left hand column—and sum up the columns singly and in order, from left to right. You must not go over and correct your work. Try to add right the first time. But you must add just as fast as you can. When I say 'stop' you must cease at once no matter where you are in the column." (The subjects might be told to make a check at this point, but we did not do this.)

Grading of Papers: 1. State the number of columns correctly added. 2. State the number of columns wrongly added. Allow 4% for columns correctly added. Allow 2% for columns incorrectly added.

Caution: Some pupils may write sums at the bottoms of the columns without going through the process of adding. Give no credit for such responses.

4. TABLES

TABLE 13

Addition of One-Place Digits: C1–5

Scores Based on Columns Correctly and Incorrectly Added

NORMAL CHILDREN

No.	Ae.	Sx.	1′	2′	f 2/1	3′	f 3/2	4′	f 4/3	5′	f 5/4	1–2′	4–5′	f 4–5/1–2	f 5/1	1–5′	Gain Ave. 1–5′
2	7	B	3.0	4.0	1.33	6.0	1.50	5.0	.83	4.0	.80	3.5	4.5	1.28	1.14	4.4	.2
2	7	G	14.0	10.0	.55	11.0	1.10	13.0	1.20	9.0	.70	12 0	11.0	.94	.72	11.5	−1.4
4	7	Av.	8.5	6.0	.94	8.5	1 23	9.0	1.07	6 5	.73	10 3	7.7	1.05	.92	7 9	− 5
7	8	B	8.5	8.5	1.00	6 5	.85	9 3	1.55	9.1	1.06	8.7	8 3	1.23	1.14	8.5	.1
3	8	G	8 6	12.0	1.05	10.0	.86	12.6	1.21	9 3	70	10 3	11.0	1.03	1.11	10 5	.1
10	8	Av.	8.6	9 8	1.20	7.8	.85	10.5	1.44	9.2	.94	9 2	9.4	1.16	1.13	9 1	.1
3	9	B	7.3	4.0	1.50	11.3	1.45	10.0	1 18	10 6	1 05	8.6	10.3	1.92	2.20	9 5	.9
4	9	G	7.0	5.0	.66	9.3	1 15	8 0	.98	9.5	1 27	6.5	8.7	2.55	1 62	7 7	.7
7	9	Av.	7.1	4.5	1 22	10.3	1.30	8 8	1 08	10.0	1.17	7.4	9.4	1.30	1.87	8 5	.8
4	10	B	16.0	19 3	1.15	18 6	.99	15.0	1.06	17 0	.99	17 2	17.2	1.03	1 11	17.1	.2
3	10	G	13 0	12.0	.93	12.0	1.00	13.0	1.15	16.0	1.37	12.5	14.5	1.20	1 22	13 2	.7
7	10	Av.	15 0	16.4	1.06	16.0	.99	14 3	1.09	15 6	1.11	15.6	16.3	1.08	1 15	15 8	.4
3	11	B	22.0	18 6	.88	18.0	.96	18.0	1 10	21.3	1.16	20.3	19.6	.98	96	19 6	— .2
8	11	G	16.7	17.2	1.25	15.7	85	17.7	1.32	16.8	.98	17.0	17.1	1.12	1 27	16.8	.03
11	11	Av.	18.1	17.6	1.15	16.4	80	17.8	1.26	18.2	1.04	17 9	17 8	1.05	1.18	17.6	— .07
5	12	B	22 8	19.2	.87	25 2	1.35	22 0	95	20.4	.92	21.0	22 2	1.08	.94	22.5	— .6
3	12	G	20.6	20.0	1.06	24.6	1.23	20.0	.83	25.3	1.24	20.3	22.6	1.18	1.06	22 1	1.1
8	12	Av.	22.0	19.5	.94	25.0	1.30	24.0	.90	22.2	1 04	20.7	22 5	1.11	1.10	22 0	.04
4	13	B	24.5	26.6	1.16	30.5	1 16	31.0	.97	29.5	94	26.5	30.2	1.12	1.17	28.7	1.3
1	13	G	18.0	18.0	1.00	20 0	1.11	18 0	.90	22.0	1.22	18.0	20.0	1.11	1.22	19.2	1.
5	13	Av.	23 2	24.5	1.12	28.4	1.15	28.4	.95	25 0	1.00	24.8	28.2	1.12	1.18	26.8	1.2
3	14	B	29.5	26 0	85	32.0	1.25	35.3	1.18	23 0	.74	27 6	32.6	1.24	1.01	30.3	1
7	14	G	29.4	29.7	1.01	32.4	1.17	35 4	1.19	31.4	.88	29.5	33 4	1.15	1.06	31.6	5
10	14	Av.	29.4	28 6	.97	32 2	1.20	35 4	1.19	29.5	.85	29 0	33.2	1.18	1.05	31.2	.4
2	15	B	33.0	32.0	.98	46 0	1.35	42.0	1.12	37.0	.86	32.5	39.5	1 20	1.10	36.4	1.1
2	15	G	24.0	21.0	.87	31.0	1.50	29.0	.93	31.0	1 04	22 5	30.0	1 30	1.27	27.2	1 7
4	15	Av.	28.5	26.5	92	36.0	1.44	35 5	1.02	34.0	.95	27.5	34 7	1.26	1.19	31 8	1.4
1	16	B	16.0	16.0	1.00			22.0	1.37	22.0	1.00	16.0	22 0	1.37	1.37	19.0	2.
3	16	G	30.0	26.0	.77	22.0	.87	22.6	1.05	23 3	1.06	26.3	23.0	.80	.75	24.2	−1.8
4	16	Av.	26.5	22.5	.85	22.0	.87	22.5	1 13	23.0	1.05	23.7	22.7	.98	.90	22.9	−1.
1	17	B	38.0	40.0	1.05	52.0	1.30	46 0	.88	48.0	1.04	39.0	47.0	1.20	1.04	44.5	2.5
2	17	G	23.0	12.0	.75	19.0	.90	25.0	1.36	21.0	.82	21.0	23.0	1.10	.90	21.7	— .5
3	17	Av	28.0	26.0	.90	30.0	1 03	32 0	1.20	30.0	.89	27 0	31.0	1.13	1 02	29.4	.5
Ave. B. ..			18.2	17.6	1.02	20.1	1.18	21 3	1.15	19.5	98	17 9	20.4	1.18	1.19	19.4	4
Ave. G. .			19.2	19.0	1.08	19.2	1.03	20.7	1.14	20.1	1.00	19.1	2.04	1.26	1.17	19.7	.2
Ave. B.& G			18.7	18 3	1.05	19.7	1.10	21.0	1 15	19.8	99	18.5	20.4	1.22	1.18	19 5	.3

TABLE 14.

Addition of One-Place Digits: C1—5

Scores Based on Columns Correctly and Incorrectly Added.

EPILEPTICS.

Su.	Ae.	Sx.	1/1	2/1	f 2/1	3/1	f 3/2	4/1	f 4/3	5/1	f 5/4	1-2/1	4-5/1	f 4-5/1-2	f 5/1	1-5/1	Gain Ave. 1-5/1
81	10	B	2	.....	...	....	....	1	2.00	0	.00	2	2	1.00	.00	2.0	— .1
102	10	G	4	6	1.50	0	.00	4	.....	8	2.00	5	6	1.20	2.00	4.4	1
104	10	G	6	6	1.00	4	.66	2	.50	6	3.00	8	4	.66	1.00	4 8	0.
	Av.	G	5	6	1.25	2	.33	3	.50	7	2.50	5.5	5	92	1 50	4 6	.5
59	11	G	2	0	....	12	....	....		0	.00	1	6	6.00	.00	3.5	— .6
79	12	B	0	0		4	2.00	8	2.00	.....	.	1	6	6 00	.....	1.5	2.6
84	12	B	8	8	1.00	14	1.75	30	1.42	22	1.10	8	21	2.62	2 75	14.4	3 8
91	12	B	10	26	2.00	16	.80	20	1.25	18	.90	15	19	1 26	1 80	16.8	2.
..	Av.	B	6	10	1.50	11.3	1 51	16	1.55	20	1.00	8	15.3	3 29	2.27	12.1	2 7
103	12	G	0	0		0	.	0	.....	0	.	0	0	.....	.	0	0.
93	13	B	2	4	2 00	6	1 50	6	1 00	2	33	3	4	1.33	1 00	4.	0.
86	13	B	4	4	1.00	6	1.50	8	1.33	0	.00	4	4	1.00	.00	4.4	—1.
	Av.	B	3	4	1.50	6	1 50	7	1.16	1	.16	3 5	4	1.16	.50	4.2	— .5
97	13	G	6	4	.66	4	1.00	..	.....	14	3.50	5	9	1 80	2.33	7.	2.6
77	14	B	10	10	1.00	12	1 20	12	1.00	12	1 00	10	12	1 20	1.20	11 2	.5
89	14	B	4	8	2.00	8	1.00	14	1.75	8	57	6	11	1.83	2.00	8.4	1.
.	Av.	B	7	9	1.50	10	1.10	13	1.37	10	.78	8	10.6	1.51	1.60	9.8	.7
80	15	B	6	4	.66	14	3 50	12	.85	14	1 16	5	13	2 60	2 33	10.	2.
82	15	B	0	2	.....	4	2 00	6	1 50	4	.	16	1	5	5.00	.	3.2	1.
83	15	B	12	12	1.00	10	83	16	1.60	14	.87	12	15	1.25	1 16	12.8	.5
....	Av.	B	6	6	83	9.3	2.11	11 3	1.31	10 6	89	6	11	2.95	1.74	8 6	1.1
78	16	B	6	4	.66	5	1.50	8	1.33	10	1.25	5	9	1.80	1.66	6.8	1.
88	16	B	18	24	1 33	20	83	14	.70	14	1 00	21	14	.66	.77	18.	—1.
85	16	B	12	10	.83	6	.60	10	1.66	10	1 00	11	10	.90	.83	9 6	— 5
...	Av.	B	12	12.6	.94	10.6	.97	10.6	1.23	11.3	1.08	12.3	11	1.12	1.05	11.4	— .1
96	16	G	0	8		8	1.00			12	1.50	4	10	2.50		7.	4.
98	16	G	22	.....	.....	18	.81	20	1 11	20	1 00	20	20	1.00	.91	20.	— .6
106	16	G	8	6	.75	5	1.00	8	1 33	8	1.00	7	8	1.14	1 00	7.2	0
100	16	G	4	4	1.00	6	1 50	5	1.00	4	.66	4	5	1.25	1.00	4.8	0.
.	Av.	G	8.5	6	.87	9.5	1.07	11.3	1 14	11	1 04	8.7	10.7	1 57	.97	9 3	.7
87	17	B	4	2	.50	10	5 00	14	1.40	24	1.71	3	19	6.33	6.00	11 2	5
90	17	B	8	0	.00	12	...	8	56	8	1.00	3	8	2.66	1.33	6 8	.5
....	Av.	B	5	1	.25	11	5 00	11	1 03	16	1 35	3	13.5	4.49	3.66	9 0	2.7
95	17	G	4	0	.00	6	.....	8	1.33	2	25	2	5	2.50	.50	4	— .5
105	18	G	8	2	.25	8	4.00	4	.50	6	1.50	5	5	1.00	75	5.6	— .5
107	21	G	10	6	.60	5	1 33	6	.75	6	1.00	8	6	75	.60	7 2	—1.
101	24	G	2	2	1.00	2	1.00	2	1.00	4	2 00	2	3	1.50	2.00	2 4	5
Ave. B			6.5	7.6	1 07	9.8	1.71	11.2	1.34	10.6	83	6 7	10.9	2 34	1.63	9 1	1 0
Ave. G			6.	3.4	.67	6.2	1.23	5.8	.90	6.5	1.37	4.7	6 2	1 77	1.02	5.6	15
Ave. B & G			6.2	5.6	.90	8.1	1.51	9 0	1.18	8.7	1.08	5 9	8.8	2.08	1.35	7.5	63

TABLE 15

Addition of One-Place Digits: C1–5: Scores Based on Columns Correctly Added

NORMAL CHILDREN

Su.	Ae.	Sx.	1/2	2/2	f 2/1	3/2	f 3/2	4/2	f 4/3	5/2	f 5/4	1–2/2	4–5/2	f 4–5/1–2	f 5/1	1–5/2	Gain Ave. 1–5/2
2	7	B	0.	2.0	..	6.3	1.00	4.0	.66	.0	.00	1.0	2.0	2.00	.	2.4	0
2	7	G	8.0	4.0	.33	4.0	1.00	8.0	1 00	2.0	.25	7.0	5	70	.16	5.3	—1.7
4	7	Av.	4.0	2.6	....	5.0	1.66	6.0	.83	1.0	.16	4.0	3.5	1 13	....	3.8	— .8
5	8	B	5 7	4 7	.76	5 7	1 81	5.1	1.10	5.0	.80	5.2	5.0	1.26	1.01	5.2	— .2
3	8	G	5.3	10.6	1.76	8.0	1.02	9.3	1 27	5.3	.33	8.0	7.3	.88	1.00	7.7	0
11	8	Av.	5 6	6 3	.88	6 4	1.38	6.4	1.16	5.0	.62	6.0	5.6	1 14	1 01	5 6	— .1
3	9	B	6.6	2.0	1.00	7.3	.75	4.6	1.41	7.3	1.77	6.6	6.	.81	.75	6 3	1
4	9	G	3.	2.6	1.00	4.0	1.00	3.0	.25	6.0	1.75	3.5	4.5	.88	1.66	3 9	8
7	9	Av.	4 5	2.4	1.00	5.6	.90	3.7	.95	6.5	1 76	4.8	5.1	.85	1.30	4 9	.5
4	10	B	15.0	18.6	1.22	16.0	88	16.0	1.25	15.0	.95	15.5	15.5	.98	1.03	15 2	0
3	10	G	10 2	6.6	.66	5.3	.75	6.6	1.83	9.3	1.50	8 6	8.0	.83	.94	7.7	— .3
7	10	Av.	13.1	12.6	.94	10 6	.83	12.0	1 44	12.5	1.13	12 5	12.0	.91	.99	12 2	— .1
3	11	B	20.0	14.6	.81	9.3	.78	12.0	1.88	9.3	.91	17.3	10.6	.50	50	13.0	0
8	11	G	14.5	13.5	1.03	12.0	.83	14.5	1.20	13.1	.86	14.0	14.0	1.09	1 26	13.6	.4
11	11	Av.	15.0	13 8	.96	11.2	.81	13 8	1.41	12.0	.88	14.9	13.0	.96	1 01	13.4	.2
5	12	B	18.4	15 2	.98	17.6	1.11	18.0	67	8 0	.32	16.8	12 0	72	64	15 1	—4.
3	12	G	17.3	14.6	1.19	21.3	1 48	16.0	.86	24.0	1.48	16.0	20.0	1.59	2 17	18 6	1.6
8	12	Av.	18.0	15.0	1.06	19.0	1.25	17.1	.75	14.0	.76	16 5	15.0	1 05	1.21	16.4	1 8
4	13	B	20.0	25.3	1.20	27.0	1.21	26.0	.85	25.0	1.02	23.0	25.5	1.00	1 12	24 8	1 3
2	13	G	8 0	8.0	1 00	8.0	1.00	8.0	1.00	10.0	1.25	8.0	9 0	56	1.25	8 4	.5
6	13	Av.	16.0	18.4	1.15	20.6	1.17	20.0	88	20.0	1.06	18.0	20.0	.85	1 15	19 3	1.0
4	14	B	19.0	15.0	.64	22.0	1 49	32.0	1.22	10 6	.61	17.0	21.5	1.09	.97	19.5	0
7	14	G	25 7	26.0	.92	28.8	1.39	30.8	1.65	24.0	1.18	25.1	27.4	1.11	.78	26.8	— .4
11	14	Av.	23 2	21.0	.76	25.7	1 43	31.2	1.54	20.0	1.06	22.1	25 3	1.10	.84	24.0	.3
2	15	B	32.0	26.0	.83	44.0	1.83	42.0	1.18	32 0	.76	29.0	37.0	1.27	1.00	33.3	0.
2	15	G	22.0	16.0	.67	28.0	2.00	28.0	1 04	30.0	1 04	19 0	29.0	1 60	1.33	24.8	2.
4	15	Av.	27 0	21 0	75	33.0	1 94	35.0	1.11	31 0	.90	24.0	33 0	1.43	1.16	29.3	1.0
1	16	B	8 0	12.0	1.50	....	..	20.0	1.66	20.0	1.00	10.0	20.0	2.00	2.50	15.0	5
3	16	G	29.3	22.0	63	12 0	.50	13.3	1.35	17.3	1.20	22.0	15.3	.62	.52	17 8	—3.5
4	16	Av.	24.0	18 6	.92	12.0	.50	15.0	1.45	18 0	1.15	19 0	16 5	97	1 01	17.1	—1 7
1	17	B	36.0	36.0	1 00	52.0	1.44	44 0	.84	44.0	1.00	36.0	44.0	1 22	1 22	42.4	2
2	17	G	16.0	4.0	1.00	14.0	.92	20.0	2 16	14 0	.62	15 0	17.0	1.27	92	15.9	— .5
3	17	Av.	22.6	20.0	1 00	26 6	1.09	28.0	1.72	24.0	.75	22.0	26.0	1 25	1.02	24.7	3
Ave. B			14.6	13.4	.93	16 0	1.20	17.0	1.19	12.5	.90	14.0	14.6	1.05	.95	14 7	— .3
Ave. G.			15.4	13.8	90	13 9	1 07	15 5	1 30	14 8	1 03	14.7	15.2	1.03	1.09	14 7	— .1
Ave. B & G			15.0	13.6	.92	14 9	1.13	16.2	1.24	13 7	.97	14.4	14.9	1 04	1.02	14.7	— .2

TABLE 16

Addition of One-Place Digits: C1—5: Scores Based on Columns Correctly Added

EPILEPTICS

Su.	Ae.	Sx.	1 %	3 %	f 2/1	3 %	f 3/2	4 %	f 4/3	5 %	f 5/4	1–2 %	4–5 %	f 1–5/1–2	f 5/1	1–5 %	Gain Ave. 1–5 %
81	10	B	0	....		....		4	....	0	.00	0	2	..	.. .	1.3	0.
102	10	G	4	4	1 00	0	.00	4	....	8	2.00	4	6	1.50	2.00	4.0	1.
104	10	G	4	4	1.00	4	1.00	0	.00	4	....	4	2	50	1.00	3 2	0.
....	Av.	G	4	4	1.00	2	.50	2	..	6	2.00	4	4	1.00	1 50	3.6	.5
99	11	G	0	0	...	0	....	...	....	0	.	0	0	....	..	0	0.
79	12	B	0	0		0		4		..	..	0	2		....	1 0	1.3
84	12	B	0	4	....	8	2.00	20	2.50	20	1.00	2	20	10 00		10.4	5
91	12	B	8	2	.25	16	8.00	20	1.25	16	.80	5	18	3.60	2.00	12.4	2.
..	Av.	B	2 6	2	.25	8	5.00	14.6	1.87	18	.90	2.3	16	6.80	...	8.4	2.9
108	12	G	0	0	....	0	.	0	....	0	....	0	0	...	.00	0.	0.
93	13	B	0	0	....	0	...	0	....	0	....	0	0	.	.00	0.	0.
86	13	B	0	0	....	4	..	8	2.00	0	.00	0	4	....	2.4	2.4	0.
	Av.	B	...	....	....	2	.	4	2.00	....	...	..	2		..	1.2	0.
97	13	G	4	0	.00	0	....	..		12		2	6	3.00	3 00	4.0	2.6
77	14	B	4	8	2.00	4	50	4	1.00	4	1.00	6	4	.66	1.00	4.8	0.
89	14	B	4	0	.00	4	....	8	2.00	0	.00	2	4	2.00	.00	3 2	−1.
	Av	B	4	4	1.00	4	50	6	1 50	2	50	4	4	1.33	50	4.0	− .5
[illegible]	15	B	0	4		12	3 00	8	.66	12	1 50	2	10	5.00	.	7.2	3
82	15	B	0	0	...	0		4		0	00	0	2	..	.	.8	0.
83	15	B	12	12	1 00	8	.66	16	2.00	12	.75	12	14	1 16	1.00	12 0	0.
	Av.	B	4	5 3	1 00	6 6	1 83	9.3	1.33	8	.75	4 6	8.6	3.08	50	6 6	1.
103	15	G	8	0	.00	4	....	4	1.00	0	00	4	2	50	.00	3.2	−2
78	16	B	0	0	.	4	....	4	1 00	4	1 00	0	4	..		2.4	1.
[illegible]	16	B	16	24	1.50	20	.83	12	.60	12	1.00	20	12	60	75	16.8	−1.
85	16	B	[illegible]	4	.	0	.00	0		4	....	2	2	1.00	....	1.6	1.
....	Av.	G	5.3	9.3	1 50	8	.41	5 3	.80	6 6	1.00	7.3	6	.80	2.91	6.9	.3
96	16	G	0	8	.	8	1 00	....		12	1.50	4	10	2.50	.	7.0	4.
[illegible]	16	G	20	...		8	.40	4	.50	8	2 00	14	6	43	40	10.0	−4.
106	16	G	[illegible]	4	.50	4	1 00	8	2 00	4	.50	[illegible]	6	1.00	50	5 6	−1.
100	16	G	0	0	.	4	..	0	.00	0	....	0	0	....	....	[illegible]	0.
....	Av.	G	7	4	.50	6	.80	4	.83	6	1 33	5.7	5 1	1.31	.30	5.5	− .2
87	17	B	0	0		0	....	4	.	0	00	0	2	.	...	.8	0.
90	17	B	4	0	00	12	...	4	33	4	1 00	2	4	2 00	1.00	4.8	0.
....	Av.	B	2		.00	6	....	4	33	2	50	1	3	2.00	1.00	2 8	0.
95	17	G	0	0		4	....	4	1.00	0	00	0	2	.	....	1 6	0
105	17	G	0	0		4		4	1 00	4	1.00	0	4	..	....	2.4	−1.
107	21	G	8	0	.00	4	..	0	.00	0		4	0	.	.	2.4	−2.
101	24	G	0	0		0	...	0	....	0	....	0	0		....	.0	0.
Ave B.			3.4	3.8	.79	6.1	2 40	7.5	1.33	5.8	.62	3.4	6.7	2.60	.96	5.2	.7
Ave G.			3	1.5	.41	3.1	1.67	2.5	[illegible]	3.7	1.00	2.8	3.2	1 18	.98	3.0	- .07
Ave B & G			3.1	2.7	.60	4 7	2.04	5 4	1 04	4.8	.75	3 1	5.1	1.97	.97	4.2	.35

5. RESULTS (See Tables 13, 14, 15, and 16)

We have tabulated the scores in two ways. First, we have given the results in Tables 13 and 14 in terms of a combined quantitative and qualitative score, allowing 4% for a correctly added column and 2% for an incorrectly added column. Since the test was given as a time or speed test it seems justifiable to give half credit for columns incorrectly added because it probably required just as much time to sum up a column that was incorrectly added as one that was correctly added[1], and because the mistakes frequently may be largely due to the necessary hurry of the work.

[1]Of course, this would not be true of careless pupils who were less concerned about the accuracy of their work, than covering a large number of columns. We eliminated the records of four of the normal pupils who seemed from the internal evidence merely to have written sums at the foot of the columns without actually summing up the figures. One "dull" boy of 14 in the seventh grade and an "average" boy of 8 in the third grade seemed to have written mere guesses; a "bright" girl of 13 in the seventh grade seemed from the answers to have added together a number of columns. She wrote such answers as the following: in 2, "2935;" in 3, "3313;" in 4, "4533;" and in 5, "97740." One "dull" girl of 10 in the fifth grade added 3 columns correctly in the first sitting. After that all were wrong. She covered 5 columns in the second sitting, 6 in the third, 32 in the fourth and 24 in the sixth.

Second, in Tables 15 and 16 we have based the scores on the columns correctly added (accuracy scores), allowing no credit whatever for columns incorrectly added. The reader may base his conclusions on either of these two methods of scoring; we shall compare the results of both methods.

COMPARATIVE EFFICIENCY

Based on the columns both correctly and incorrectly added, Table 13, the average efficiency for all the normals for the five sittings was 19.5% and for all the epileptics, Table 14, 7.5%. The epileptics' average was only 38% as high as the normals' average. The epileptics did not do quite as well as the youngest group of normals, and only 25% as well as the oldest group. Basing the results only on the columns correctly added, Tables 15 and 16, the corresponding average for the normals is 14.7%, which is 75% of the normals' combined score in Table 13, while for the epileptics it is 4.2%, which is only 56% of the epileptics' combined score in Table 14. The epileptics' comparative efficiency is only 28% of the normals when the scores are based only on the columns correctly added. They did a little better than the normal seven-year-olds, but only 17% as well as the oldest group. In other words, the epileptics added relatively more columns incorrectly than did the normals.

The boys' ability to add, based on the combined averages in Tables 13 and 14, for all the boys in all five sittings was very slightly less than the girls' among the normals, but decidedly higher among the epileptics. The normal boys did 98% as well as the normal girls, while the epileptic girls only did 61% as well as the epileptic boys. The girls did better in three sittings and poorer in two sittings among the normals and poorer in all the sittings among the epileptics, based on the general averages at the foot of the columns. Based on the averages for all the sittings the normal girls did better than the normal boys in four ages and poorer in seven ages, while the epileptic girls did better than the epileptic boys in only two ages and poorer in four ages, no comparison being possible in the other ages.

When the results are based on the corresponding averages for the scores correctly added in Tables 15 and 16, no difference is found between the general averages of all the five sittings for the normal boys and girls, while the girls are superior in three sittings and inferior in two, based on the general averages at the foot of the columns. On the other hand, the epileptic girls did only 57% as well as the epileptic boys in the general averages, while they were decidedly inferior to the boys in all sittings except one. The girls did better than the boys among the normals in six ages and poorer in five. Among the epileptics they did better than the boys in only two ages and

poorer in four, while no comparative data are available in the other ages. We find, therefore, no significant difference in this addition test between the normal boys and girls, but the epileptic boys did decidedly better than the epileptic girls.

Based on the averages for the two sexes for all the five sittings, the performance in this test improves with ascending age among the normals in eight ages while it decreases in only two ages, when the scores in each age are compared with the scores in the next higher age. The results are the same whether based on Table 13 or Table 15. The losses occur in age nine, in which 57% are backward or dull (which, however, is a smaller per cent than the per cent of backward or dull in age eight, while it is the same as in age ten); and in age 16, in which 75% of the pupils are classed as average or dull. The improvement shown in this test with increasing age is in accordance with expectation, because the older pupils are not only more mature but have had more training in the use of the fundamental mathematical processes. The difference between the averages in the lowest and in the highest age amounts to 20.9% (24.7%–3.8%, Table 15). But here, again, the score for age 15, in which there are no dull pupils, is higher than the score for age 17, in which all the pupils were average or dull.

There is no consistent increase among the epileptics. The records of the four oldest epileptics are almost on a par with those of the youngest epileptics.

Based on the combined scores, one epileptic was not able to score a single point in any sitting, two failed entirely in two sittings, and nine in one sitting. Based on the scores for only the columns correctly added, three failed completely in all five sittings, five in four sittings, four in three sittings, six in two and six in one sitting. Only some of these failures could be attributed to antecedent convulsions—notably in the case of the single failures of Nos. 102, 79, 86, 103, and 95. Among the normal children, only one child (No. 5, again) failed in all the sittings based on the combined scores, while two failed in one sitting, an "average" boy of eight and a "dull" girl of ten, both in the second grade. When the scoring was based only on the columns correctly added, three failed in all the sittings, two in four, two in three, seven in two, and eleven in one.

Both the normals and the epileptics in both tables made their highest average in the fourth sitting and their lowest average in the second sitting.

COMPARATIVE IMPROVEMENT

The average monthly improvement made by each normal subject during all the sittings was only .3%, when the combined scores are considered, Table 13, while there was an average loss of .2% when the scores are based only on the columns correctly added, Table 15. The gains for the epileptics, based on the corresponding scores, were .63% and .35%. Based upon the com-

bined scores, the epileptics gained 210% more than the normals. According to the indices of improvement, the gain in the fifth sitting over the first ($f \frac{5}{1}$) amounted for the normals to 18% when based on the combined scores and only 2% when based only on the columns correctly added. The corresponding figures for the epileptics are 35% and a loss of 3%, a difference of 17% in favor of the epileptics in the first instance and of 5% in their disfavor in the latter instance. The gain in the last two sittings over the first two ($f \frac{4-5}{1-2}$) amounted for the normals to 22% when based on the combined scores and only 4% when based only on the columns correctly added. The corresponding figures for the epileptics are 105% and 4%, a difference, respectively, of 83% and 0% in favor of the epileptics.

The following are the per cents of gain based on each index of improvement:

	Combined Scores				Correct Scores Only			
Index	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$
Normals	5%	10%	15%	–1%	8%	13%	24%	–3%
Epileptics	10%	51%	18%	8%	40%	104%	4%	–25%

Based on the combined scores, the normal pupils gained 15% more than the epileptics in the second sitting, while the epileptics gained 41% more than the normals in the third sitting, 3% more in the fourth, and 9% more in the fifth. The greatest variation from sitting to sitting is among the epileptics. In one sitting they improved 104% while in another they lost 40%, based on the results for the columns correctly added. Some epileptics who did absolutely nothing on some days made a fair score on other days. Based on the figures in the column giving the average monthly gain for sittings 1 to 5, combined scores, 10 epileptics lost and five made no improvement, which is 50% of all the epileptics, while the corresponding figures for the normals are 25 and 8, which is 45% of all the normal pupils (72 in this table). Based on the scores for the columns correctly added in Tables 15 and 16 the figures for the epileptics are six losses and fourteen no gains, which is 66% of all the epileptics, and for the normals thirty-two and nineteen, which is 67% of the normal children.

The absolute average monthly gain was twice as great for the normal boys as for the normal girls (.4% vs. .2%), when based on the average score for the columns correctly and incorrectly added, while the loss for the boys was three times as great as the loss for the girls when based only on the scores for the columns correctly added (–.3% vs. –.1%). Among the epileptics the gain was over six times as great for the boys as for the girls, based on the figures in either table. Based on the average indices of improvement at the bottom of the columns, the normal boys gained more (or lost less) than

the normals girls in three successive indices, and gained less in three, in both tables, while the epileptic boys gained more than the epileptic girls in all indices except one, for the combined scores and except two for the correct scores. The gain in the fifth sitting over the first ($f\frac{5}{1}$), combined scores, was only 2% greater for the normal boys than for the normal girls (19% vs. 17%), but 61% greater for the epileptic boys than the epileptic girls (63% vs. 2%). Based on the scores for the columns correctly added, the gain was 14% greater for the normal girls than for the normal boys (−5% vs. +9%), while the loss was 2% less for the epileptic girls than for the epileptic boys (−2% vs. −4%). The gain based on the average of the last two sittings compared with the average of the first two ($f\frac{4-5}{1-2}$), was 8% greater for the normal girls than for the normal boys (26% vs. 18%), and 65% greater for the epileptic boys than for the epileptic girls (134% vs. 69%), when the results are based on the combined scores. When the results are based only on the columns correctly added, the normal boys gained 2% more than the normal girls (5% vs. 3%), and the epileptic boys 142% more than the epileptic girls (160% vs. 18%). It is evident that the results are not consistent. Apparently the girls, both normal and epileptic, do comparatively better when the results are based only on the columns correctly added, but the epileptic boys tend rather consistently to improve more than the epileptic girls.

There is a very slight tendency for the improvement among the normal pupils to increase with ascending chronological age. When the average monthly gains ($\frac{\text{Gain}}{1-5}$) are compared in each successive age (as indicated on p. 50), there is improvement in six of the successive ages and losses in four, in both tables. When the results are based on the index of $\frac{4-5}{1-2}$, there is an increase in seven ascending ages and a decrease (or equal scores) in only three, based on the figures in both tables. The results for the epileptics are too irregular to justify comparison.

6. CONCLUSIONS

1. The ability of our normal pupils to add as determined by this test was decidedly inferior to the ability shown in the same test under the same time limitations by our dental group of children, the dental group doing almost 100% better (37.6% vs. 19.5%). We do not know how to account for this large difference. It might be assumed that it is due to the larger number of younger children in our New Jersey group than in our Cleveland group. But the Cleveland children are superior in every age from 10 to 16 where comparisons are possible. The explanation may be that better training was afforded in arithmetic in the Cleveland schools. It should be remembered, however, that the Cleveland average is based on the six series of tests given in the course of a whole year.

Based on the results of these two groups of normal children we may say that this test, under the conditions in which it is given, is applicable for use with normal school children over 7 or 8 years of age.

2. The epileptics' ability to add was decidedly inferior to the ability of normal children to add, and this is particularly true so far as concerns the epileptics' ability to add correctly. The epileptics did only 38% as well as the normals on the combined scores and only 28% as well on the accuracy scores.

3. There is no significant difference in the ability to add between the normal boys and girls in this experiment. The odds, however, are slightly in favor of the girls. In the previous use of the test with the dental group of normal children, the boys did decidedly better. Among the epileptics in this experiment the boys excelled decidedly.

4. The capacity to add increases from age to age among normal children, due to increasing mental maturity as well as increasing practice. The oldest pupils do over three and a half times as well as the youngest, based on the combined scores, and six and one-half times as well, based on the accuracy scores.

5. Large individual differences exist in the ability to add, as shown by the extreme variations in the individual scores in each sitting, based (a) on the combined scores (Tables 13 and 14) and (b) on the columns correctly added (Tables 15 and 16).

	1		2		3	
	(a)	(b)	(a)	(b)	(a)	(b)
For the epileptics	0 to 22%	0 to 20%	0 to 24%	0 to 24%	0 to 20%	0 to 20%
For the normals	0 to 58%	0 to 56%	0 to 70%	0 to 64%	0 to 74%	0 to 72%

	4		5	
	(a)	(b)	(a)	(b)
For the epileptics	0 to 20%	0 to 20%	0 to 24%	0 to 20%
For the normals	0 to 78%	0 to 76%	0 to 76%	0 to 76%

The individual differences in each age for the normals are as follows, based on the averages for all sittings (1–5):

Age	7	8	9	10	11	12	13	14	15	16	17
Difference (a)	12.0	12.0	13.0	14.8	23.6	14.9	29.6	54.2	21.2	13.8	30.4
Difference (b)	5.6	15.2	10.6	20.8	24.8	14.8	44.0	67.8	30.0	22.6	37.6

5. The average monthly improvement during the five sittings was, on the whole, greater for the epileptics than for the normal children, both absolutely and relatively, whether based on the combined scores or only on the accuracy scores. The greater improvement made by the epileptics is due to their poor initial records and their great variability, which produced oc-

casional excessive gains. The monthly improvement in absolute terms, however, was small for either group. One-half of the epileptics as against 45% of the normals made no improvement or actually lost during the experiment.

7. We do not find any significant difference in the average amount of monthly improvement between the normal boys and girls, although in our previous experiment with the dental group the boys improved more than the girls. The epileptic boys clearly improved more than the epileptic girls.

8. There is a very slight tendency toward an increase in the monthly improvement as the normal children grow older.

9. The increase in ability to add with increasing age and with time indicates that this test can be used to measure growth in mental capacity, resulting from increasing maturity and from practice. Simpson found a correlation in an addition test of .72 with the estimated intelligence in his "good" group of subjects.[1] Chapman found a higher correlation (0.96) between his initial and final scores in his addition test than in any of his four other tests.[2] We would emphasize, however, that the test presupposes specific training or familiarity with the process of addition; success in the test depends, of course, on other factors than general intelligence.

[1]Benjamin R. Simpson, Correlation of Mental Abilities, 1912.

[2]J. Crosby Chapman. Individual Differences in Ability and Improvement and their Correlations, 1914.

We cannot here attempt to assemble the considerable experimental literature which exists on some of the tests which resemble our own. The literature has been summarized by Guy Montrose Whipple in his Manual of Mental and Physical Tests: Part I, 1914, and Part II, 1921.

V. CONTROLLED ASSOCIATION

Antonym Test With Supplied Key-Words: D1 to D5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

Twenty-five words were printed in 12 point type on each of six blanks, measuring 4 x 12 inches. These blanks also served as record sheets. The 150 words used in the complete set of blanks (only the first five of which were used in this experiment) were selected from a larger preliminary list. The attempt was made to select 150 simple words, all of which should, if possible, be familiar to even younger children and all of which should have familiar antonyms. It is no easy task to arrange six lists containing 25 words each of equal difficulty. In the first place, it is difficult, if not impossible, to select 150 words the meanings of which are equally familiar to children of different ages. Second, it is still more difficult to select 150 words with equally familiar antonyms. The opposites of some words are suggested very frequently by our daily experiences, while the opposites of other words, the meanings of which may be equally familiar, are rarely suggested. Some words allow of several synonymous antonyms, or antonyms corresponding to the various shades of meaning attaching to the words, while others have only one antonym. Some words permit one or several partially correct antonyms, while others have only one recognized opposite. In view of these difficulties, which would have led us to reject this test had it not been for the recognized merit of the opposites test as a test of intelligence, it seemed to us that the only feasible way of constructing approximately equal lists of words was to distribute in each test an approximately equal number of easy and hard words—i. e., easy and hard from the standpoint of the familiarity of their antonyms—to allow one-half credit for partly correct antonyms, and to instruct the subjects to pass over difficult words, but to return to them later if the time permitted.[1] We distributed the 150 words, as best we could, according to this plan and then submitted the six lists to two instructors in a teachers' training school, with the request that they rearrange them independently of each other, so that, according to their judgment, each test would contain an equal number of easy and difficult words, and so that the six lists would be of equal difficulty. The final arrangement represents the best compromise that could be made from the judgments of three workers. It would, of course, require an extended investigation on children of different ages experimentally to construct such lists as these, or to demonstrate whether or not our lists are of equal difficulty. In our previous experimental use of

[1] A number of subjects followed this suggestion, but we do not know how many were able to return to difficult words. Judging by the records very few had time to do so.

this test there was a consistent and considerable increase in the scores from sitting to sitting.[1] In the present investigation, however, the increase was not uniform for either the normals or the epileptics, while the highest score was made by the normals in the fourth sitting and by the epileptics in the third sitting. In both investigations the lowest score was made in the first sitting, due probably to lack of familiarity with the test. Our general impression of the lists is that they are fairly satisfactory, although not absolutely uniform in difficulty.

2. NATURE AND PURPOSE OF THE TEST

This is recognized as one of the best tests of intelligence of the so-called controlled association or selective thinking type. Simpson found that the degree of correlation between his easy opposites test and the intelligence of people in general amounted to 0.82, while for the hard opposites test it reached 0.96.[2] In order properly to perform the test the subject must possess accurate knowledge of the meanings of the key-words, he must be able to conceive of the opposite meanings of the words, to do which he must be able to compare, and particularly to abstract differences, and, finally, he must be able to select the right word to express the difference. The number of words written in the test represents the speed of associating antonyms with the key-words plus the time required to write the antonyms. As we have stated in Chapter III (which see) the necessity for writing the associates delayed and complicated the responses. It is possible that the older and more intelligent subjects mentally "filled in" more antonyms than they had time to write, while the younger children probably were embarrassed by the difficulty of writing and spelling.

3. DIRECTIONS FOR GIVING THE TEST

General Directions: See pages 15 to 17.

Order of Giving Tests: First sitting, D1. Second sitting, D2. Etc.

Time: 60 seconds (one minute, precisely). Place the papers upside down on the pupils' desks. Caution pupils not to turn them until directed to do so.

Instructions to Pupils: "On the other side of the papers placed on your desks is a list of words. The moment I say 'turn' you must turn your papers over at once, and write opposite each word the word which means just the opposite; that is, has just the opposite meaning. For example (explain, using these illustrations on the board): Better—worse. Correct—incorrect. Sunset—sunrise. If you cannot think of the opposite of any given word proceed to the next, and return to the word later if there is time. Write as many

[1] Dental Cosmos, 1912, 404f. and 545f.
[2] Benjamin R. Simpson. Correlation of Mental Abilities, 1912.

correct opposites as you can. If you are troubled about the spelling of words, spell them as well as you can, and don't lose any time trying to think of how to spell words. Nothing will be taken off for words spelled incorrectly." (During the later sittings the first four or five words of D1 may be used as illustrations.)

"Now, ready!" "Turn!"

"Now, stop!" "Turn!" "Sign your names."

Scoring: The grading in this test is based on the quality of the responses. Each perfect antonym, 4%. Each partly correct antonym, 2%. Correct idea, but expressed in two words, 2% (but if a conventional phrase, 4%). No credit when the key-words are repeated and prefixed by "not." For errors in the form of the word (which are not mere errors in spelling the word) deduct 2%. The following "key" prepared largely on the basis of the words which have been actually given in the experiments thus far conducted with the test, was followed in grading the papers:

KEY TO GRADING OF TESTS D1 TO D6

D1

	Perfect 4%	Partly Correct 2%
Someone	Noone, Nobody, None	
Idle	Industrious, Busy, Occupied, Employed	Ambitious, Energetic, Working, Thrifty
Useless	Useful, Usable	Serviceable, Beneficial, Worth, Something of use
Gain	Loss, Deficit, Lose	Privation, Waste, Damage
Naked	Clothed, Clad, Robed, Gowned, Covered, Dressed	
Ugly	Beautiful, Pretty, Handsome, Nice	Attractiveness, Splendid, Ornate, Good looking, Good
Odd	Even, Ordinary, Usual, Common, Familiar	
Rim	Center, Hub	Inside, Middle
Wider	Narrower	Closer, Thinner
Break	Mend, Repair, Join, Rebuild	Construct, Make, Fixed, Fasten
False	True, Genuine, Right, Correct	Honest, Ingenuous, Good, Real
Purity	Impurity, Uncleanness, Foulness, Uncleanliness, Dirtiness	Corruption, Impure, Unclean, Dirty
Wife	Husband	Man
Cloudy	Clear, Bright, Fair	Sunny, Moonlight, Starry, Sunshine, Shiny
Top	Bottom	
Deep	Shallow, Superficial, High	
Bachelor	Maid, Spinster, Virgin, Married man	Married
Front	Back, Rear	Behind, End
Ripe	Green, Unripe, Raw, Immature	Undeveloped

Teacher	Pupil, Scholar, Learner, Disciple, Student	
Large	Small, Little	Inconsiderable, Insignificant
Spend	Save, Horde, Accumulate, Retain	Hold, Keep
Empty	Full, Fill, Filled	Replenished, Replete
Ceiling	Floor	Base, Foundation
Hilly	Flat, Plain, Level	Smooth, Even

D2

	Perfect 4%	Partly Correct 2%
Bad	Good, Virtuous, Right	Excellent, Moral, Correct
Outside	Inside, Internal	In, Inner, Within, In it, Indoors
Scarce	Plentiful, Abundant, Frequent, Common	General, Many, Plenty, Enough
Quick	Slow, Sluggish	Lazy, Slowly
Shaky	Steady, Firm	Established, Strong, Even, Fast, Still
Known	Unknown, Unfamiliar	Unrecognized
Big	Little, Small	Short
Seldom	Frequently, Often, Frequent	Always, Every time
Less	More	Increased
Buyer	Seller, Salesman, Vender	Hawker, Peddler
Sugar	Salt	Vinegar, Acid, Sour
Doubtful	Certain, Sure, Doubtless	Know
Weak	Strong, Mighty, Vigorous, Robust, Powerful	Able, Capable, Efficient
White	Black	Light, Brown
Stale	Fresh	Preserved, Wholesome
Like	Dislike, Unlike, Different, Dissimilar	Hate, Don't like
Birth	Death	Decay
Either	Neither	None
Sick	Well, Healthy	Healthful, Wholesome, Comfortable
Glad	Sad, Sorry, Unhappy	Mad, Angry, Sorrowful
Thin	Thick	Fat, Bulky, Stout
Brother	Sister	
Many	Few	None, Infrequent, Rare
Above	Below, Beneath, Underneath	Under
Sink	Rise, Ascend, Mount, Soar, Float	Swim

D3

	Perfect 4%	Partly Correct 2%
Wrong	Right, Correct, Proper	
Up	Down	Below
Wet	Dry	
New	Old	Aged, Ancient
High	Low	Deep
Cool	Warm	Hot, Heated

Soft	Hard	Stony, Rigid, Unyielding, Rough
Laugh	Cry	Frown, Moan, Cried
Tight	Loose, Slack	
Always	Never	No time
Happy	Sad, Unhappy, Sorry	Sorrow, Grieved, Sorrowful
Wise	Unwise, Foolish, Stupid, Imprudent, Indiscreet, Silly	Ignorant, Dull, Dumb
Follower	Leader	
Forget	Remember, Retain, Hold	Remind, Know
Winter	Summer	
Blunt	Sharp, Pointed, Acute	Polished
Strife	Peace, Concord, Amity	Love
Off	On	
Wild	Tame, Civilized, Cultivated, Peaceful, Domesticated, Sane, Gentle	Calm
Beginning	End, Terminus, Close, Conclusion, Ending, Finishing, Finish	
Coarse	Fine, Refined, Polished, Cultured, Cultivated	Smooth, Thin
Something	Nothing	
Liquid	Solid	Dry
Push	Pull, Draw, Drag	
Queen	King	Ruler

D4

	Perfect 4%	Partly Correct 2%
Great	Little, Small	Insignificant, Inferior
Hot	Cold	Cool
Dirty	Clean	Pure
Able	Unable, Impotent, Incapable, Weak, Inefficient, Ineffective, Incompetent, Feeble	Can't, Cannot
Late	On or in time, Punctual, Early	
Miss	Mr., Master, Hit, Strike, Catch	Man, Mrs.
Dress	Undress, Disrobe, Suit of Clothes (or Coat and Pants)	Coat, Pants
Sowing	Reaping, Harvesting, Mowing	Picking
Left	Right, Came, Taken	
Height	Depth, Lowness	Low (Length? Width?) Breadth
This	That	
Yes	No, Nay	
Dark	Light, Fair, Bright, Clear	White
Evil	Good, Beneficial	Wholesome, Right
Cowardly	Brave, Bravely, Courageous, Daring, Heroic, Bold, Valiant, Fearless	Manly

North	South	
Yours	Mine	My
Drop	Hold, Pick up	Raise, Lift, Keep
Open	Closed, Shut, Ajar, Close	Locked
Round	Square	Lean, Flat, Straight
War	Peace, Amity, Concord	
East	West	
Raise	Lower, Depress, Lay down, Depreciate	Drop
Rough	Smooth, Sleek, Refined, Calm, Tranquil	Even, Easy, Fair
Noisy	Silent, Quiet, Still	

D5

	Perfect 4%	Partly Correct 2%
Day	Night	
Asleep	Awake	Wake
Heavy	Light	Animated
Best	Poorest, Worst	
Add	Subtract, Detract, Diminish, Take away	Decrease
Careless	Careful, Cautious, Heedful, Circumspect	Anxious, Thoughtful, Neat
Same	Different, Opposite	Unlike, Another
Loud	Soft, Low, Softly, Quiet	Silent, Weak, Still
Expensive	Cheap, Economical	
Giving	Taking, Receiving	Keeping, Stingy
Joy	Sorrow, Grief, Misery, Melancholy, Sadness	
Much	Little	Less
Near	Far, Distant, Remote	Away
Profit	Loss, Debit	Waste, Damage
Come	Go, Leave	
Woman	Man	
Tall	Short, Stunted	Little, Low, Small
Absent	Present, Here	
Son	Daughter	
Country	City, Town	
Straight	Curved, Crooked	Round, Bent
Backward	Forward, Frontward	
Nowhere	Somewhere	Everywhere
Success	Failure	
Lean	Fat, Stout, Plump	Thick, Heavy

D6

	Perfect 4%	Partly Correct 2%
Girl	Boy, Lad	
In	Out	Outside
Alike	Different, Unlike, Dissimilar	Opposite
Mind	Body, Disobey, Disregard	
Future	Past	Ancient, Old, Now, Present

Him	Her	
Over	Under, Underneath	Below
Slowness	Fastness, Rapidity, Quickness, Promptness, Speed	
Sweet	Sour, Acid, Bitter, Salt	
Foot	Head, Hand, Top	
First	Last, Hindmost	
Morning	Evening, Eve	Night
Broad	Narrow	Thin
Dead	Alive, Living	Animate
Ocean	Land	Continent
Hollow	Solid, Filled, Genuine	
Rooster	Hen	Chicken
Upper	Lower	
Here	There	Away
Love	Hate, Hatred, Malice, Coldness	Dislike
Sharp	Blunt, Dull, Obtuse	
Rich	Poor	
Young	Old, Aged	
Stay	Go, Depart, Leave, Proceed	
Friend	Foe, Enemy, Adversary, Antagonist	

4. TABLES

TABLE 17

Antonym Test: D1—5

NORMAL CHILDREN

No.	Ae.	Sx.	1/n	2/n	f 2/1	3/n	f 3/2	4/n	f 4/3	5/n	f 5/4	1–2/n	4–5/n	f 4–5/1–2	f 5/1	1–5/n	Gain Ave. 1–5/n
2	7	B	2.0	14.0	7.00	12.0	.85	10.0	.83	12.0	1.20	8.0	11.0	1.37	6.00	10.0	2.5
2	7	G	6.0	20.0	1.66	30.0	2.00	22.0	.80	12.0	.53	13.0	17.0	1.25	1.32	17.2	1.7
4	7	Av.	4.0	16.0	4.33	21.0	1.42	16.0	.81	12.0	.75	10.5	14.0	1.34	3.66	13.6	2.1
8	8	B	6.7	13.7	2.41	24.5	1.69	20.0	.63	14.5	.64	10.2	16.0	1.45	3.01	15.4	1.9
3	8	G	1.3	6.6	.50	5.3	1.06	26.0	.50	11	.00	3.0	1.5	.38	.00	3.2	— .3
11	8	Av.	5.2	11.8	2.05	19.2	1.59	14.2	.60	10.5	.50	8.5	12.0	1.09	2.41	12.0	1.3
3	9	B	2.0	5.0	2.25	22.6	1.89	18.6	.57	8.0	.42	12.6	13.3	1.05	1.00	14.3	0.
4	9	G	13.0	14.0	1.03	35.3	1.91	28.0	1.03	20.5	.57	15.5	24.0	1.44	1.53	21.0	1.6
7	9	Av.	10.8	12.0	1.44	29.0	1.90	24.0	.83	15.1	.52	14.3	19.5	1.31	1.32	18.1	.9
4	10	B	21.0	33.3	2.20	43.3	1.28	41.0	1.03	40.0	.98	27.7	40.5	1.58	1.95	35.1	5.4
3	10	G	21.3	29.0	2.29	36.6	1.31	35.3	.94	30.6	.89	25.8	33.0	1.62	2.59	30.6	2.3
7	10	Av.	21.1	31.3	2.25	40.0	1.30	38.5	.99	36.0	.94	26.7	37.4	1.60	2.65	33.2	4.0
3	11	B	25.3	32.6	1.38	49.3	1.91	44.0	.94	46.6	1.03	29.0	45.8	1.55	1.72	39.6	5.3
8	11	G	26.7	34.2	1.23	46.7	1.48	43.6	.87	37.7	1.00	30.5	42.3	1.43	1.53	38.3	3.6
11	11	Av.	26.3	33.8	1.27	47.4	1.60	43.7	.89	40.4	1.01	30.0	43.1	1.46	1.59	38.6	4.0
5	12	B	36.0	42.8	.96	44.0	1.02	52.5	2.78	42.4	.80	39.4	45.2	1.01	1.14	42.7	1.6
3	12	G	22.0	34.6	2.87	50.0	1.35	51.3	1.16	42.0	.74	28.3	46.0	1.63	2.33	40.0	5.0
8	12	Av.	30.7	39.7	1.91	46.2	1.16	52.0	2.08	42.2	.78	35.2	45.7	1.28	1.65	41.7	2.7
4	13	B	44.0	52.0	1.13	55.0	1.16	53.5	.99	48.0	.88	46.2	50.7	1.06	2.57	49.8	1.0
2	13	G	31.0	27.0	.57	52.0	1.94	32.0	.53	46.0	1.91	30.0	39.0	1.70	1.00	38.0	3.2
6	13	Av.	40.3	42.0	.99	54.0	1.42	46.3	.83	47.8	1.19	40.5	47.0	1.27	2.25	45.8	1.8
4	14	B	46.5	48.0	1.09	46.0	.88	63.3	1.07	47.3	3.26	47.2	49.2	1.00	1.42	48.6	1.5
7	14	G	48.8	54.5	1.23	66.0	1.18	63.1	.95	62.2	1.00	51.7	62.7	1.25	1.46	58.1	3.6
11	14	Av.	48.0	52.1	1.29	57.0	1.05	63.2	1.09	57.8	1.68	50.0	57.8	1.16	1.44	54.6	2.9
2	15	B	88.0	91.0	1.03	80.0	.81	90.0	1.10	94.5	1.04	89.5	87.2	.98	1.07	89.3	1.8
2	15	G	82.0	77.0	.94	79.0	1.02	85.0	1.07	93.0	1.09	79.5	89.0	1.11	1.13	83.2	2.7
4	15	Av.	85.0	84.0	.98	79.3	.95	87.5	1.08	93.7	1.07	84.5	88.1	1.06	1.10	86.2	2.3
1	16	B	66.0	46.0	.69	.		62.0	1.34	52.0	.83	56.0	57.0	1.01	.78	56.5	—4.6
3	16	G	60.3	62.0	.98	66.3	1.08	56.0	.81	64.6	1.14	62.3	60.3	.95	1.01	61.5	.3
4	16	Av.	64.0	56.6	.88	66.6	1.08	57.5	.94	61.5	1.06	60.6	59.5	.96	.95	60.3	— .7
1	17	B	56.0	42.0	.75	60.0	1.42	54.0	.90	64.0	1.18	49.0	59.0	1.20	1.14	55.2	2.
2	17	G	70.0	56.0	1.07	76.0	1.04	74.0	1.01	88.0	1.19	73.0	81.2	1.18	1.32	76.3	5.2
3	17	Av.	65.3	49.0	.91	70.6	1.17	67.3	.97	80.3	1.19	65.0	73.8	1.19	1.26	69.2	4.0
Ave. B			29.2	34.8	1.72	39.4	1.37	41.8	1.11	36.5	1.06	31.9	39.1	1.24	1.92	36.2	2.1
Ave. G			33.7	37.6	1.41	48.8	1.37	45.2	.92	44.0	.92	35.5	44.6	1.29	1.62	41.8	2.7
Ave. B & G			31.5	36.2	1.55	44.2	1.37	43.6	1.01	40.3	.98	33.7	42.0	1.27	1.77	39.1	2.4

TABLE 18

Antonym Test: D1—5

EPILEPTICS

Su.	Ae.	Sx.	1	2	f 2/1	3	f 3/2	4	f 4/3	5	f 5/4	1–2	4–5	f 4–5/1–2	f 5/1	1–5	Gain Ave. 1–5
81	10	B	0	..	....	....	....	4	..	0	.00	0.	2	....	..	1 3	0.
102	10	G	0	0	..	0	..	6	..	12	2.00	0.	0	....	..	3.6	3
104	10	G	0	0	....	0	..	4	...	0	.00		2		..	0	0.
...	Av.	G	0	0	..	0	....	5	....	6	1.00	0.	5.5	....	....	2 7	1.5
99	11	G	0	0	....	2	....	...	...	0	.00	0.	0	..	....	.5	0.
79	12	B	0	0	...	0		4	....	....	....	0.	2	....	....	1.0	1.3
84	12	B	12	16	1.33	32	2 00	24	.75	24	1.00	14.	28	2 00	2.00	21.6	3.
91	12	B	0	0	....	4		0	.00	0		0.	0	....	....	0	0.
...	Av.	B	4	5 3	1.33	12	2.00	9.3	.37	12	1.00	4.6	10	2 00	2.00	8 2	1.3
108	12	G	0		...	0	....	0	..	0	..	0	0	..	..	0	0.
93	13	B	0	0	....	0	....	0	....	0	....	0	0	..	...	0.	0
86	13	B	0	0	....	0	.	0	....	0		0	0	....		0.	0.
97	13	G	0	20	..	8	.40	.	...	4	5	10	4	.40	....	8	1.3
77	14	B	8	24	3.00	38	1.58	18	.47	24	1 33	16	21	1 31	3 00	22 4	4
89	14	B	6	12	2.00	0	.00	8	..	20	2.50	9	14	1 55	3 33	9 2	3.5
...	Av.	B	7	18	2.50	19	.79	13	.47	22	1.91	12.5	17.5	1 43	3 16	15 8	3.7
80	15	B	0	14	..	24	1.71	8	.33	8	1 00	7	8	1 14	....	10.8	2
82	15	B	14	24	1.71	34	1.41	20	.58	16	.80	12	18	94	1 14	21 6	.5
83	15	B	4	16	4.00	24	1 50	12	50	12	1 00	10	12	1 20	3.00	13.6	2.
...	Av	B	6	18	2.85	27.3	1.54	13.3	.47	12	93	8 6	12 6	1 09	2 07	15 3	1.5
103	15	G	0	0	...	0	.	0	....	0	...	0	0	.	.	0	0.
78	16	B	4	8	2.00	8	1.00	4	.50	10	2.50	8	7	1 16	2.50	6 8	1.5
88	16	B	8	20	2.50	20	1.00	8	.40	12	1.50	14	10	71	1 50	13 6	1.
85	16	B	0	20	...	8	40	12	1.50	18	1.50	10	15	1 50	....	11 6	4.5
...	Av.	B	4	16	2.25	12	.80	8	.80	13.3	1.83	10	10.6	1 12	2 00	10.6	2 3
96	16	G	0	4	....	0	.00	...	...	0	....	2	0	00	....	1 0	0.
98	16	G	0	.	....	1	....	18	4 50	12	.66	....	15	....	..	8.5	1
106	16	G	0	2	....	4	2 00	0	.00	2		1	1	1 00	....	1.6	5
100	16	G	0	0	...	8	....	4	.50	0	.00	0	2	....	..	2.4	0.
...	Av.	G	0	2	....	4	1.00	7.3	1.66	3.5	33	1	4.5	50	....	3.2	1
87	17	B	0	0	....	0	..	0	....	.	....	0	0	.	..	0	0.
90	17	B	0	0	....	0	....	0	....	0	...	0	0	....	....	0	0.
95	17	G	0	0	...	0	....	0	.	0	....	0	0	....	.	0	0.
105	18	G	0	0	....	0		0	..	0	....	0	0	....	....	0	0.
107	21	G	4	8	2.00	8	1.00	12	1.50	16	1 33	8	14	2 33	4 00	9.6	3
101	24	G	0	4	...	0	.00	0	..	0	....	2	0	00	..	8	0
Ave. B....			3.5	10.2	2.29	12.8	1.17	7.6	.55	10 2	1.31	6 7	8 8	1 28	2 35	8 7	1.5
Ave. G.....			2	3 1	2.00	2.4	.68	4.0	1.62	3 2	62	1.6	3 6	.74	4 00	2.5	.8
Ave. B & G			2.0	7.1	2.25	7.7	1 00	6.1	.88	6.4	1.03	4 4	6.4	1 09	2 56	5 9	1.2

5. RESULTS (See Tables 16 and 17)

COMPARATIVE EFFICIENCY

The average efficiency for all the normals in all the five sittings (Column 1–5) was 39.1%, and for the epileptics 5.9%. The epileptics were only 15% as efficient as the normal children in supplying antonyms. The epileptics did less than half as well as the youngest normals, the seven-year-olds, and about one-twelfth as well as the oldest normals.

The boys' capacity, based on the general average at the bottom of the column for all five sittings (1–5), was appreciably inferior to the girls' among the normals but decidedly superior to the girls among the epileptics. The normal boys did 86% as well as the normal girls, while the epileptic girls did only 28% as well as the epileptic boys. The normal girls did consistently better in every sitting than the normal boys, while the epileptic boys did de-

cidedly better than the epileptic girls in every sitting, based on the sex averages at the bottom of the columns. Based on the sex averages in the different ages for sittings 1 to 5 (next to the last column in the tables), the normal girls did better than the normal boys in five ages, but poorer in 6, while the epileptic girls did poorer in three ages, and better in two ages than the epileptic boys, the averages were the same in one age, and no data were available in the other ages. The girls in this test proved to be slightly superior to the boys among the normals, but decidedly inferior among the epileptics.

There is a very considerable improvement from age to age in this test. Based on the averages for the two sexes for sittings 1 to 5, there is an improvement in eight ascending ages and a loss in only two, when the averages in a given age are compared with the averages in the next higher age. The losses occur in ages 8 and 16, in which a preponderance of the children were classed as average, namely, 72% in age 8 and 75% in age 16. The decidedly best record was made by the 15-year-olds, three-fifths of whom were classed as bright. The 17-year-olds, who were all classed as dull and average, did only 80% as well as the 15-year-olds.

The difference between the youngest and the oldest subjects tested amounts to 55.6%.

The records for the epileptics do not show any consistent gain with increasing age. Most of the oldest epileptics do worse than the youngest ones.

Nine epileptics failed to make a score in any sitting in this test, while fourteen made no scores in one or more sittings. Clearly this test was too difficult for the epileptics. On the other hand, one of the normal pupils failed completely in all of the sittings (No. 5, the "dull" and inattentive 8-year-old boy in the second grade), two failed in four sittings (one an "average" boy of eight in the second grade and one a "bright" boy of ten in the second grade), three failed in three sittings, three in two sittings and six in one sitting. Only three of these 15 pupils were above the third grade, while six were in the second grade. Eight of these pupils were eight years old and one seven, and only two were above ten years. A considerable number of seven- and eight-year-old children will fail in this test.

Both the normals and the epileptics made their highest score in the third sitting, and their lowest score in the first sitting.

COMPARATIVE IMPROVEMENT

The average monthly gain made by each subject during all the sittings (last column in the tables) amounted, in the absolute units, to 2.4% for the normals, and 1.2% for the epileptics, who therefore improved only 50% as much as the normals. In relative amount of improvement, i. e., relative to the size of the average scores, the epileptics did better, owing to the fact that their scores were considerably lower than those of the normals. This is

shown by a comparison of the indices of improvement. The percentage of improvement made in the second sitting compared with the first, in the third compared with the second, etc., is shown by the following figures:

	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$	$\frac{5}{1}$	$\frac{4-5}{1-2}$
Normals	55%	37%	1%	–2%	77%	27%
Epileptics	125%	0%	–12%	3%	156%	9%

The normals gained 37% more than the epileptics in the third sitting, 13% more in the fourth, and 18% more in the average of the fourth and fifth compared with the average of the first and second. The epileptics, on the other hand, gained 70% more than the normals in the second sitting, 5% more in the fifth, and 79% more in the fifth sitting compared with the first. In the aggregate the epileptics gained rather more than the normals. The epileptics' records, however, are very erratic, as may be seen from the table, and the improvement is sometimes more apparent than real, due to the fact that a child may fail in one sitting adequately to comprehend the meaining of the test, while in the next sitting he understands just what is wanted. A large improvement under such conditions does not indicate any increase in capacity, but merely a correct understanding of the problem. In our earlier work on the dental group we had reasons to suspect that the large gains made by a few pupils were due to this circumstance. The normals' gain consistently declined after the second sitting, while the relative improvement for the epileptics was higher in the fifth than in the third or fourth sittings. The normals lost in one of the five sittings, while the epileptics lost in one and failed to improve in one sitting. Based on the average monthly gain for sittings 1 to 5, fifteen epileptics, or one-half of the epileptics, made no improvement, while nine normals showed losses and fourteen made no gains, which is 30% of the normals.

The absolute average monthly gain for all the sittings was almost one and a third times greater for the normal girls than for the normal boys (2.7% vs. 2.1%), but almost two times greater for the epileptic boys than for the epileptic girls (1.5% vs. .8%). Based on the average indices of improvement at the bottom of the columns, the normal boys gained more than the normal girls in all the indices, except $\frac{4-5}{1-2}$ (the indices are equal in $\frac{3}{2}$), while the epileptic boys also gained more than the epileptic girls, except in one index. The gain in the fifth sitting, compared with the first, was 30% more for the normal boys than for the normal girls (92% vs. 62%), while for the epileptics it was 165% greater for the girls than for the boys (300% vs. 135%). The gain based on the average of the last two sittings compared with the average of the second and third ($f\frac{4-5}{1-2}$), was 5% less for the normal boys than for the normal girls (24% vs. 29%), while it was 54% more for the epileptic boys than for the epileptic girls (a gain of 28% vs. a loss of 26%).

When each age is compared with the next succeeding age for the normal pupils the amount of the improvement, based on the average monthly gain in the final column, decreases in six ascending ages and increases in only 3, while the gains are equal in one age. Based on the index $f\frac{+}{-}\frac{?}{?}$ there is a decrease in seven ascending ages and an increase in only three. In other words, the older normal children were functioning nearer their limit at the beginning than the younger children. With the epileptics the results are very irregular.

6. CONCLUSIONS

1. In this type of controlled association test the normal children did only about three-fourths as well as the dental group of children in our earlier experiment. This large difference may be due to the fact that the dental group was allowed 25 seconds longer in which to do the test, and also to the absence of children under ten in the dental group. The dental group was superior in four and inferior in three of the ages that could be compared. It should be stated, again, that the averages for the dental group are based on six tests given during the course of one year. Tests on our two normal groups indicate that the opposites test with our arrangement of words and time limitations can be successfully used with children of eight or nine and over.

2. The epileptics were surprisingly deficient in the ability to give antonyms under the conditions of this test, doing only about one-seventh as well as the normal children.

3. The normal girls slightly excelled the boys in this experiment, but the boys were appreciably better than the girls in the dental group. The epileptic boys were decidedly superior to the epileptic girls.

4. The knowledge of antonym equivalents or the ability to associate words of opposite meaning to given key-words, clearly increases from age to age among normal children, due, no doubt, to increasing experience as well as to increasing mental maturity. Our oldest group of normal pupils does more than five times as well as the youngest group.

5. The individual differences in the ability to give antonyms are strikingly large. The following are the extreme variations between the lowest and the highest individual scores in each sitting:

	1	2	3	4	5
For the epileptics	0 to 14%	0 to 24%	0 to 38%	0 to 24%	0 to 24%
For the normals	0 to 94%	0 to 98%	0 to 96%	0 to 98%	0 to 98%

The individual differences in each age, based on the average scores for all the sittings (1–5), among the normal children are as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	22.4	31.8	36.4	25.2	43.0	49.2	46.0	72.7	13.4	36.7	35.0

6. The improvement shown in this test during the course of the experiment does not always indicate an increase in mental capacity, but merely a clearer comprehension of the problem. The large gains made by a few of our normal and epileptic subjects can be thus explained. On the whole, the normal pupils improved more than the epileptics. They improved twice as much in absolute units while the greater relative gains (based on the indices) made by the epileptics in some sittings are due to very inferior initial scores, or to abnormally large gains, due to the reason given above, or to the frequent inability to compute the indices for many subjects because of the presence of zero scores, which circumstance unavoidably introduces errors. One-half of the epileptics did not make any gains as against 30% of the normal pupils.

7. Although the results are somewhat discrepant, the average monthly improvement in this test is slightly greater for the normal girls than for the normal boys. In the experiment on the dental group the girls likewise improved more than the boys. But the epileptic boys, on the whole, gained more than the epileptic girls. However, in view of the discrepancies we cannot conclude that the sex differences are significant in this test.

8. There is perhaps a slight decrease in the average amount of monthly improvement with ascending age, which would seem to indicate that the older pupils were functioning nearer their maximum at the outset—and that some of the younger pupils made abnormally large gains because of a lack of clear comprehension of the test at the beginning.

9. This appears to us to be one of the most valuable tests for measuring developing intelligence, as indicated by the consistent increase in the age curve among normal pupils. But as a test for measuring improvement in mental growth with lapse of time it is subject to the weaknesses pointed out above. Chapman also found great irregularities in the opposites test and a lower degree of correlation (.59) between the initial and final scores than he found in any of the other four tests which he used.[1] Proficiency in the test, of course, is dependent upon familiarity with words and their opposite meanings, and this is dependent not only upon memoriter knowledge of words, but upon the ability to compare, analyze, and abstract constrasting aspects of our experience. For clinical purposes the test is probably best given orally instead of in writing.

[1] J. Crosby Chapman, Individual Differences in Ability and Improvement and their Correlations, 1914, p. 31.

VI. ATTENTION AND PERCEPTION

Speed and Accuracy of Perceptual Discrimination in the Crossing Out of A's: E1 to E5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

Twenty-six lines of capitals were printed in 12 point type on sheets of paper measuring 6½ x 12 inches. A test sheet is reproduced below. The capitals were distributed promiscuously in each line. No attempt was made to make all the lines exactly equal in length. On the other hand, in order to secure successive sheets of equal difficulty great care was taken to change the placement of the letters in the different lines, so that no duplicate lines would occur on the different sheets, particularly in the lines that the subjects would probably have time to get over (and only a few such duplications occur), and so that there would be approximately the same number of A's (the letter which was to be crossed out) in each successive group of four or five lines. The following tabulation shows that approximately the same number of A's occurred in the first five, ten, fifteen and twenty lines in each of the successive sheets:

Number of A's	Number of Test					
	1	2	3	4	5	6
In first 5 lines.....	39	37	38	37	36	40
In first 10 lines.....	78	77	74	77	78	81
In first 15 lines.....	116	113	116	115	116	115
In first 20 lines.....	155	152	151	153	154	154

OYKFIUDBHTAGDAACDIXAMRPAGQZTAACVAOWLYX
WABBTHJJANEEFAAMEAACBSVSKALLPHANRNPKAZF
YRQAQEAXJUDFOIMWZSAUCGVAOABMAYAAZJDAL
JACINEVBGAOFHARPVEJCTQZ9PJLEIQWNAHRBUIAS
SNZMWAAAWHACAXHXQAXTDPUTYGSKGRAVLGKIM
FUOFAAKYFGTMBLYZIJAAVAUAACXDTVDACJSIUFMO
TXWAMQEAKHAOPXZWCAIRBRZNSOQAQLMDGUSGB
AKNAAPLPAAAHYOAEKLNVFARJAEHNPWIBAYQRK
UPDSHAAQGGHTAMZAQGMTPNURQNXIJEOWYCREJD
UOLJCCAKSZAUAFERFAWAFZAWXBAAAVHAMBATAD
KVSTVNAPLILAOXYSJUOVYIVPAAPSDNLKQRAAOJLE
GAAQYEMPAZNTIBXGAIMRUSAWZAZWXAMXBDXAJZ

ECNABAHGDVSVFTCLAYKUKCWAFRWHTQYAFAAAOH
GAAQYEMPAZNRTIPXGAIMRUSAWZAZWXAMXBDXAJZ
ECNABAHGDVSVFTCLAYKUKCWAFRWHTQYAFAAAOH
UOLJCCAKSZAUAFERFAFWAFZAWXBAAAVHAMBATAD
KVSTVNAPLILAOYSJOUVYIBPAAPSDNLKRQAAOJLE
AKNAAPLPAAAHYOAEKLNVFARJAEMNPWIBAYAQRK
UPDSHAAQGGHTAMZAQGMTPNURQNXIJEOWYCREJD
TXWAMQEAKHAOPXZWCAIRBBZNSOQAQLMDGUSGB
FUOFAAKYFGTMBLYZIJAAVAUAACXDTVDACJSIUFMO
SNZMWAAAWHACAXHXQAXTDPUTLGSKGRKVLGKIM
JACINEVGBAOFHARPVEJCTQZAPJLEIQWNAHRBUIAS
YRQAQEAXJUDFOIMWZSAUCGVAOABMAYDYAAZJDAL
AYKFUIDBHTAGDAACDIXAMRPAGQZTAACVAOWLYX
WARBTHJJAENEEFAAMEAACBSVSKALLPAJNRMPKAZF
E1

It is evident that such a test as this can readily be arranged into any number of sets of uniform difficulty. We adhered to the plan previously followed in the use of this test (which was first employed by Bourdon with a different arrangement of test material) of occasionally placing two or three A's in juxtaposition. But we do not believe that is well to use these combinations, owing to the tendency of some subjects to cross two or three A's with one stroke of the pencil. Very few of our subjects did this, however, as they were especially cautioned to draw a separate line for every A.

2. NATURE AND PURPOSE OF THE TEST

This test furnishes a convenient device for measuring the speed and accuracy of perception and motor reaction and of the subject's ability to sustain attention. In order to react properly to the test the subject must be able to discriminate between the different letters, and particularly to recognize all of the successive A's, and he must be able rapidly to draw a line through the A's as soon as they are perceived. He must make a series of discriminative reactions. To continue these reactions for any length of time involves a considerable strain on the attention. The eyes must be focused continuously on the lines; no line must be missed; the letters must be accurately recognized, particularly the A's, which is rendered somewhat difficult because of the lack of spacing between the letters. If the attention relaxes some A's may be overlooked or wrong letters may be crossed. Moreover, the subject must keep the problem continuously in mind. The test can, therefore, we believe, be legitimately classified as a test of perceptual discrimination, sustained attention, and selective motor reaction.

One of the evident advantages of this test is that it can be used with individuals widely differing in mental capacity. It can be given to young or low grade children who are merely able to recognize the printed capitals, particularly the A's, and who are able to hold a pencil and to draw a line, while adolescents and probably adults are not able to make perfect scores under the prescribed conditions.

3. DIRECTIONS FOR GIVING THE TEST

General Directions: See pages 15 to 17.

Order of Giving Tests: As before.

Time: 100 seconds precisely (one minute and 40 seconds). Place papers upside down on the pupils' desks, explaining that they must not be turned over before the signal is given.

Instructions to Pupils: "On the reverse side of the paper you will find all the letters of the alphabet printed in capitals. The letters do not follow in natural order; they come without any definite order at all. Now, the moment I say 'turn' you are to turn the papers rapidly and draw a line through every capital A; you must draw a separate line for *each* A. You must take the lines in order. Begin with the first one, on the left end, then go to the second line, left end, etc. Do not miss any A's or any lines, or mark any other letters, as that will count against you. Mark all the A's you can until I say 'stop.' Let me show you what I mean." (Demonstrate what is wanted by placing a row of figures on the board and marking out the 3's. Thus: 6429856^{3}54^{3}4510987^{3}561642^{3}456^{33}.)

"Now, ready!" "Turn!"

"Now, stop!" "Turn you papers. Sign your names."

Ranking: Record the number of A's crossed. Record the number of A's missed. Record the number of wrong letters crossed. Count up to the last A crossed.

How to grade the papers in per cents on a combined qualitative-quantitative basis: For every A crossed off credit .5% (one-half per cent). For every A missed deduct .5% (one-half per cent). For every wrong letter crossed deduct .5% (one-half per cent).

4. TABLES

TABLE 19

Speed and Accuracy of Perceptual Discrimination: E1—5.

NORMAL CHILDREN

No.	Ae.	Sx.	1/%	2/%	f 2/1	3/%	f 3/2	4/%	f 4/3	5/%	f 5/4	1-2/%	4-5/%	f 4-5/1-2	f 5/1	1-5/%	Gain Ave. 1-5/%
2	7	B	14.5	36 0	1·27	21.7	1.20	22.1	1.00	18.5	.83	16.2	20 2	1.24	1.28	18.9	.8
2	7	G	23.5	24.5	1.32	26.5	1.00	25.2	.95	28.5	1.12	25.0	26 8	1.09	1.25	25.9	1.4
4	7	Av.	18.9	20.1	1.28	24·1	1 10	23.6	.97	23.5	98	2.06	23.5	1.16	1 26	22 2	1.1
8	8	B	17 5	20.7	1.22	22.2	1 09	21.9	.93	23 7	1.13	19.1	22 6	1.16	1 37	22.0	1.5
3	8	G	23 3	21.8	.96	24.6	1.14	32.0	1.31	27 0	.96	22.5	29.4	1.34	1.16	25.7	.9
11	8	Av.	19.0	21.9	1.15	22.8	1.11	24.9	1.04	24.6	1 08	20.1	24.5	1.22	1.31	23.0	1.4
3	9	B	19.3	16 7	1.01	24.5	1.24	23.3	.93	26.3	1 11	20.6	24.8	1.21	1.38	23.0	2
4	9	G	18.8	24.1	1 25	26 0	1 19	23.6	.92	25.5	1.07	21.3	24.5	1.13	1.32	23.0	1.9
7	9	Av.	19.0	21.2	1.15	25.2	1 22	23.5	.92	25 8	1.09	21.0	24 6	1.16	1.34	23.0	1.9
3	10	B	27.5	24.2	.92	25 8	.99	25.8	.99	25.5	.99	26.2	25.7	.97	[illegible]	26 0	[illegible]
3	10	G	26·6	32.5	1.21	35.8	1.10	37.8	1 05	36 5	.96	29.6	37 1	1.26	1 38	33.9	2.4
6	10	Av.	27.1	29.2	1.09	30.8	1.04	31.8	1.02	31.0	.98	27.9	31.4	1.11	1.15	29.9	1 0
3	11	B	30.1	34 0	1.12	29.0	.87	39 3	1.35	37.2	.94	32.1	38.2	1.17	1.21	34.0	1.8
8	11	G	35.1	40.8	1.17	41.3	1 01	40.6	.98	46.3	1.17	37.9	42.9	1.13	1.34	40.7	3.8
11	11	Av.	33.7	38 9	1 15	37.9	.97	40 5	1.08	43.6	1.10	36 3	41.6	1.14	1.30	38.9	3.1
5	12	B	31 4	34.0	1 08	36.0	1.10	43 5	1 17	39.7	.95	32 6	40.5	1 15	1.28	36 3	2.2
3	12	G	34.8	39.8	1 15	44.3	1.11	41.7	.97	41.5	99	37.3	41.5	1 11	1 19	40.4	1.6
8	12	Av.	32.7	36 2	1.10	37.8	1 10	42.7	1.07	40.3	.96	34.4	40.9	1.14	1.25	37.8	1.9
4	13	B	30·7	33.8	1 21	40.6	1 16	45.0	1.12	43.6	1.95	33.9	44.3	1.31	1.42	41.9	3.4
2	13	G	32 0	37.7	1.18	44.7	1 19	42.5	.93	45.7	1.09	34.9	44.1	1.26	1.43	40.5	3.4
6	13	Av.	30.6	35 4	1.19	42.6	1.17	44.1	1.06	44.0	.99	34 2	44 2	1.29	1.42	41.4	3.4
4	14	B	30.0	35 6	1 20	34.7	.97	36.8	1.04	40.2	1 10	32.8	37.2	1.12	1.31	34.9	2 4
7	14	G	39 3	45 2	1 14	46.4	1.04	48 9	1.10	53.2	1.02	42.3	45 4	1.24	1.37	47.5	3.4
11	14	Av	35 0	41.7	1.17	41.2	1.01	45 3	1.08	49.5	1.05	38.8	42.4	1.20	1 35	42.9	3.0
2	15	B	51.0	58.5	1.14	58 5	1.1	64.7	1.04	69.2	1.06	54 7	66 9	1 22	1.35	60.9	5.2
2	15	G	41.2	52 0	1.18	47.5	1.05	50.5	1.06	57.5	1.13	44 3	53.9	1.25	1.39	49.1	4.6
4	15	Av	46.1	56.3	1 15	51.2	1.07	57.6	1.05	63.4	1.09	49.5	60.4	1 22	1.37	55.0	4 9
1	16	B	51.5	52.5	1 01	.....	.....	54.0	1.02	57.5	1.06	52.0	55.7	1.07	1.11	53.8	2.0
3	16	G	44 2	50.5	1.16	52.3	1.12	56.8	1 06	63.5	1.12	47 9	60.2	1 25	1.39	54 4	5.5
4	16	Av	46.6	51.1	1.09	52.3	1.12	56.1	1.05	62.0	1.10	48.9	59 0	1.24	1.32	54.3	4.6
1	17	B	41 0	47.0	1 14	51.0	1.08	53.0	1.03	60.5	1.14	44 0	56.7	1 28	1.47	50.5	4.8
2	17	G	61.0	64.0	1.08	67 2	1 05	72.2	1 07	74.2	1.02	62.8	73.2	1.14	1.21	68.4	3 8
3	17	Av	54.3	55.5	1.11	61.8	1 06	65.8	1.06	69.6	1 06	57.2	67 7	1.19	1.38	62.4	4.1
Ave. B			27.6	30 8	1.14	30 8	1.08	35.2	1 05	35.5	1.03	29 1	35.4	1.17	1.29	31.9	2.1
Ave. G.....			33.9	38.6	1.16	41 3	1.08	42.2	1 03	45 2	1.06	36.1	43 7	1.19	1.32	39.7	3.0
Ave. B & G.			30.8	34 8	1.15	36 2	1 08	39.0	1.04	40 5	1.05	32.7	39 8	1.18	1.31	36.3	2.5

TABLE 20

Speed and Accuracy of Perceptual Discrimination: El—5

EPILEPTICS

Su.	Ae.	Sx.	1/4	2/4	f 2/1	3/4	f 3/2	4/4	f 4/3	5/4	f 5/4	1–2/4	4–5/4	f 4–5/1–2	f 5/1	1–5/4	Gain Ave. 1–5/4
81	10	H	16.0	....	.	....	.	17.0	1.06	24.5	1.44	16 0	20 7	1 29	1.53	19.1	4 2
102	10	G	20.5	32.0	1.56	25.5	.79	32.5	1 27	36.0	1.10	26.2	34.2	1 30	1.75	29.3	3 8
104	10	G	26.0	33.0	1.26	34.0	1.03	51.5	1.51	44.0	.85	29 5	47.7	1.61	1 69	37 7	4.5
	Av	G	23.2	32.5	1.41	29.7	.91	42.0	1.39	40.0	.97	27 8	40 9	1.45	1.72	33 5	4.1
69	11	G	24.0	33.5	1.39	36.5	1 08	....		48.0	1.31	28 7	42 2	1.67	2.00	35 5	8.0
79	12	B	23.5	31.0	1 31	31.0	1 00	33.5	1 08	15 0	.44	27.2	24 2	88	.63	26 8	2 1
84	12	B	22.0	23.0	1 04	29.0	1.26	30 5	1 05	34.0	1.11	22.5	32.2	1.43	1.54	27.7	3 0
91	12	B	23.5	23.0	.97	31 0	1 34	38.5	1.24	39.0	1.01	13 2	38.7	2 93	1.65	31 0	3 8
	Av.	B	23.0	25.6	1.10	30.3	1.20	34 1	1 12	29.3	.85	20.9	31.7	1 74	1.27	28.5	1 5
108	12	G	0.	4.5	....	18 5	4 11	16 0	88	14.5	.90	2.2	15.2	6 90	....	10 7	3 6
93	13	B	23 5	21.0	.89	28.5	1 35	23.5	.82	29 0	1.23	22.2	26.2	1.18	1 23	25.1	1.3
70	13	G	11.0	15.5	1 40	10.0	64	10.5	1 05	7.5	.71	13.2	9.0	.68	88	10.9	9
	Av.	B	17.2	18.2	1.14	19 2	96	17 0	.93	18 2	.97	17.7	17.6	.93	97	18.0	.2
97	13	G	19.5	22.0	1.12	23.5	1.07	..	...	21 5	.91	20.7	22 5	1.03	1 10	21.6	6
77	14	B	28.0	34.0	1.21	34 5	1.01	35.0	1.01	43.5	1.24	31 0	39 2	1.26	1.55	35.0	3 8
89	14	B	25.0	29.5	1 18	39.5	1.33	28.0	.70	32 0	1.14	22 2	30.0	1 35	1 28	30 8	1.7
	Av.	B	26.5	31.7	1.19	37.0	1.17	31.5	85	37 7	1.19	26.6	34.6	1 30	1 41	32.9	2 8
80	15	B	29.5	35.0	1 18	34.0	.97	30.0	.88	32 5	1.08	32.2	31.2	96	1.10	32.2	.7
82	15	B	14.0	28.0	2.00	20.5	.73	30 5	1.48	25.0	.81	21.0	27.7	1 31	1.78	23.6	2.7
83	15	B	16.0	25.5	1.59	30 5	1.19	34 0	1 11	24.0	.70	20.7	29 0	1.40	1.50	26 0	2.0
	Av.	B	19.8	29.5	1.59	28.3	96	31.5	1.15	27.1	.86	24.6	29.3	1 22	1.46	27.2	1 8
103	15	G	19.0	8.5	.44	24.5	2.88	22 5	91	22.5	1.00	13.7	12.5	91	1.17	19 4	8
78	16	B	14.5	22.0	1.51	21.0	95	27.0	1.28	22 5	.83	18.2	24 7	1 35	1.55	21 4	2.0
88	16	B	17 5	42.0	2.40	41.5	.98	41.5	1.00	21.5	.51	29.7	31.5	1.06	1 22	32.8	1 0
85	16	B	22.0	21.5	.97	30.5	1.37	27.0	.88	28.0	1.03	21.7	27.5	1.26	1.27	25 8	1.5
	Av.	B	18.0	28.5	1.62	31.0	1.10	31.8	1 05	24.0	.79	23.2	27.9	1.22	1 34	26 6	1 5
96	16	G	0.	11.5	..	18.0	1.56	0.	.00	27.0	....	5 7	13 5	2.37		11.3	6.7
98	16	G	29.5	..	.	25.5	.86	43 5	1.70	47.0	1.08	27.5	45.2	1.64	1.59	36.3	5.8
106	16	G	12.5	12.0	96	19.0	1.58	20.5	1.07	22.5	1.09	12.2	21 5	1 76	1 80	17.3	2.5
100	16	G	12.5	21.0	1.68	20.5	.97	22.0	1.07	20.5	.93	16.7	21.2	1.26	1.64	19 3	2.0
	Av.	G	13.6	14.8	1.32	20.7	1.24	21.5	.96	29.2	1.03	14 1	25.3	1.75	1.67	20.2	4.1
87	17	B	5.5	18.0	3.27	18.5	1.02	22.5	1.21	21.5	.95	11.7	22 0	1.88	3.90	17 2	4 0
90	17	B	0.	0.		0.	....	0.	.	0.		0	0	...		0.	0.
	Av.	B	2.7	9.0	3.27	9.2	1 02	11.2	1 21	10.7	.95	5 8	11 0	1 88	3.90	8.6	2 0
95	17	G	0.	..	..	10.5	....	10.	.95	12 0	1.20	0.	11	....		8 1	4.0
105	18	G	37.0	7.5	.20	41 0	5 46	23.0	.56	53 0	2.30	22 2	38 0	1.71	1 43	32 3	4 0
107	21	G	22.5	22.0	.97	25.0	1.12	27.0	1.08	30.5	1.12	22.2	28 7	1.29	1.35	25.4	2 0
101	24	G	0.	15.0	....	10.5	.70	19.0	1 80	8 5	44	7.5	13.7	1.82	....	10.6	2.1
Ave. B.....			18.2	24.6	1.49	26 6	1.04	26 8	1.05	24.9	.94	21.3	25 8	1.34	1.49	24.2	1.7
Ave. G. ..			15.9	18.5	1.06	23.7	1.78	23.9	1 06	29 1	1.09	15.1	26.7	1.94	1 55	22 3	3 5
Ave. B & G			17.1	21.9	1 33	25.2	1.42	25.5	1.06	26.9	1.01	19.4	26.2	1.62	1.51	23.3	2 5

5. RESULTS (See Tables 18 and 19)

COMPARATIVE EFFICIENCY

The average efficiency for all the normals in all the five sittings (column 1–5) was 36.3% and for the epileptics 23.3%. In this test the epileptics proved to be 64% as capable as the normal children. The average for the epileptics was a trifle better than the average for the youngest normals, the seven-year-olds, and 37% as good as the average for the oldest group of normals.

The boys' capacity, based on the general average at the foot of the column for the five sittings (1–5), was appreciably inferior to the girls among the normals, but slightly superior to the girls among the epileptics. The normal boys did 80% as well as the normal girls, while the epileptic girls did 92% as well as the epileptic boys. Based on the sex averages for each sit-

ting (at bottom of columns), the normal girls did better than the normal boys in every sitting, while the epileptic girls did poorer than the epileptic boys in four sittings and better in one. Based on the sex averages in the different ages for sittings 1 to 5 (next to the last column in the tables), the normal girls did better than the normal boys in eight ages, and poorer in two, while the scores were the same in one age. On the other hand, the epileptic girls did poorer in four ages and better in two than the epileptic boys, while no comparison can be made in the other ages.

The ability measured by this test improves decidedly from age to age. Based on the averages for the two sexes for sittings 1 to 5 (next to the last column in the tables), there is an improvement in seven ascending ages and a loss in two, while equal averages occur once. The losses occur in ages 12 and 16, in which 62% and 75%, respectively, of the children are classed as dull and average. The equal scores are in ages 8 and 9, in which, respectively, 72% and 57% of the children are classed as dull and average.

The difference between the youngest and oldest groups of subjects amounts to 40.2% (62.4%–22.2%). In this test the highest score does not occur, as before, in age 15, but in age 17.

Here again the epileptics fail to show consistent improvement with increasing chronological age.

This test decidedly came within the range of capacity of the epileptics. Only one epileptic failed to make any score in all the sittings, while one failed in two sittings and three in one sitting. One "bright" child in the fifth grade, curiously, made so many errors that his score was –7.5% in one sitting and –2.5% in another. His record was eliminated from the final tabulation as an abnormal record. None of the other normal children failed to make a score in any sitting.

Both the normals and the epileptics made their highest score in the fifth or last sitting and their lowest score in the first sitting, and both groups improved consistently in each successive sitting.

COMPARATIVE IMPROVEMENT

The average monthly gain made by each subject during the five sittings (last column) amounted, in absolute units, to 2.5% both for the normals and for the epileptics. The relative amount of improvement, i. e., relative to the size of the average scores—was greater for the epileptics than for the normals, as shown by the following percentages of improvement in the second sitting compared with the first, in the third compared with the second, etc. (based on the indices of improvement given at the bottom of the tables):

	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$	$\frac{5}{1}$	$\frac{4-5}{1-2}$
Normals	15%	8%	4%	5%	31%	18%
Epileptics	33%	42%	6%	1%	51%	62%

Relatively the epileptics gained more than the normals in all the sittings except one, where they gained only 4% less. In most of the sittings the difference is very considerable, amounting to 18% in the second sitting compared with the first (in favor of the epileptics), 34% in the third compared with the second, 2% in the fourth compared with the third, 20% in the fifth compared with the first, and 44% in the average of the fourth and fifth compared with the average of the first and second. In the aggregate the relative gains are considerably larger for the epileptics.

The indices show a gain in all sittings for both the epileptics and normals. The relative improvement declined in each successive sitting with one exception each for the epileptics and normals.

Based on the average monthly gain for sittings 1 to 5, one epileptic made no improvement and two showed losses, which is 10% of all the epileptics, while three normals, or 4% of all the normals, showed a loss.

The absolute monthly gain for the five sittings was one and a half times larger for the normal girls than for the normal boys (3.% vs. 2.1%) and two times larger for the epileptic girls than for the epileptic boys (3.5% vs. 1.7%). Based on the average indices of improvement at the foot of the columns the normal girls gained more than the normal boys in two sittings (or four, including $f\,\frac{4}{1}\frac{5}{2}$ and $f\,\frac{5}{1}$), less than the boys in one sitting, while the gains are equal in one sitting. The epileptic girls gained more than the epileptic boys in all the sittings (including $f\,\frac{4}{1}\frac{5}{2}$ and $f\,\frac{5}{1}$) except one, where the boys gained more. The gain in the fifth sitting over the first sitting was 3% more for the normal girls than for the normal boys (32% vs. 29%), and 6% more for the epileptic girls than for the epileptic boys (55% vs. 49%). The gain based on the average of the last two sittings compared with the average of the first two ($f\,\frac{4}{1}\frac{5}{2}$) was 2% more for the normal girls than for the normal boys (19% vs. 17%), while for the epileptics it was 60% more for the girls than for the boys (94% vs. 34%). In this test, therefore, the tendency of the girls was to gain more than the boys.

When each age is compared with the next succeeding age there is an increase among the normal pupils in the amount of improvement in five ages and a decrease in five ages also, based on the average monthly gain in the final column. Based on the index $f\,\frac{4}{1}\frac{5}{2}$, there is an increase in five ascending ages and a decrease in four, while the gains are equal in two ages. The results for the epileptics vary, entirely as before, with the individual.

6. CONCLUSIONS

1. Our normal children in this perception-reaction-attention test did only about 80% as well as the pupils in our dental experiment. This superiority of the dental group is not wholly due to the absence of children

under ten in this group, for the superiority exists in five of the seven ages which can be directly compared.

This has proved to be a very valuable test for the comparative measurement of the strength of a fairly complex trait (involving perceptual, motor and attentive factors) under easily controlled and standardized conditions, and for the measurement of the amount of improvement which may occur in the trait with time, in individuals six or seven years old and over.

2. The epileptics were about two-thirds as efficient as the normal children in the A-test.

3. The normal girls were superior to the normal boys in the A-test, not only in this experiment but also in the experiment on the dental group. But the epileptic boys were slightly superior to the epileptic girls.

4. The ability to cross out A's tends to increase from age to age among our normal pupils. The exceptions which occur may be due to a preponderance of backward children in certain ages or to the fewness of the subjects in the different ages. The achievement of our oldest group is almost three times as great as the achievement of our youngest group.

5. That the individual differences in crossing A's are very considerable is apparent from the following extreme variations between the lowest and highest individual scores in each sitting:

	1	2	3	4	5
For the epileptics	0 to 37.0%	0 to 42.0%	0 to 41.5%	0 to 51.5%	0 to 53.0%
For the normals	10% to 63.0%	15% to 65.0%	15 to 70.5%	13.5% to 73%	14% to 76%

The individual differences in each age, based on the average score for all sittings (1–5), among the normals are:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	11.6	22.2	15.0	11.4	28.5	16.9	26.1	27.1	10.9	10.3	20.1

6. In this test the average monthly improvement was greater for the epileptics than for the normal pupils. While the absolute gain was the same in both groups, the relative gain was greater for the epileptics in all the sittings except one. Since this is not a complicated test, we should suppose that the normal pupils would not need to spend much time learning how better to do the test, so that they ought to be able to function near their maximum at the outset. A part of the epileptics' gain, on the other hand, probably is due to learning better how to perform the test—how rapidly to look for the A's and to make rapid and accurate strokes. Both the normal pupils and the epileptics made consistent, though diminishing, gains in this

test from sitting to sitting. Only 10% of the epileptics and 4% of the normals failed to show a monthly improvement.

7. Both the normal and the epileptic girls improved more from month to month in the A-test, both absolutely and relatively, than the boys. In our earlier experiment the girls, again, improved slightly more than the boys.

8. There is little, if any, correlation between the amount of monthly improvement in this test and the age of the normal child. It would seem that the older pupils should not improve as much as the younger pupils, as they ought to be able to function nearer their maximum at the beginning.

9. In spite of its simplicity, our age and improvement curves both emphasize the value of the A-test for measuring mental capacity (specifically a certain type of complex trait) and mental improvement, in individuals of a very wide range of ability. Chapman's correlation between initial and final efficiency was greater for his two cancellation tests (.75 and .85) than for the opposites test, but less than for his three other tests.

VII. OBSERVATION

Range of Visual Apprehension: F1 to F5

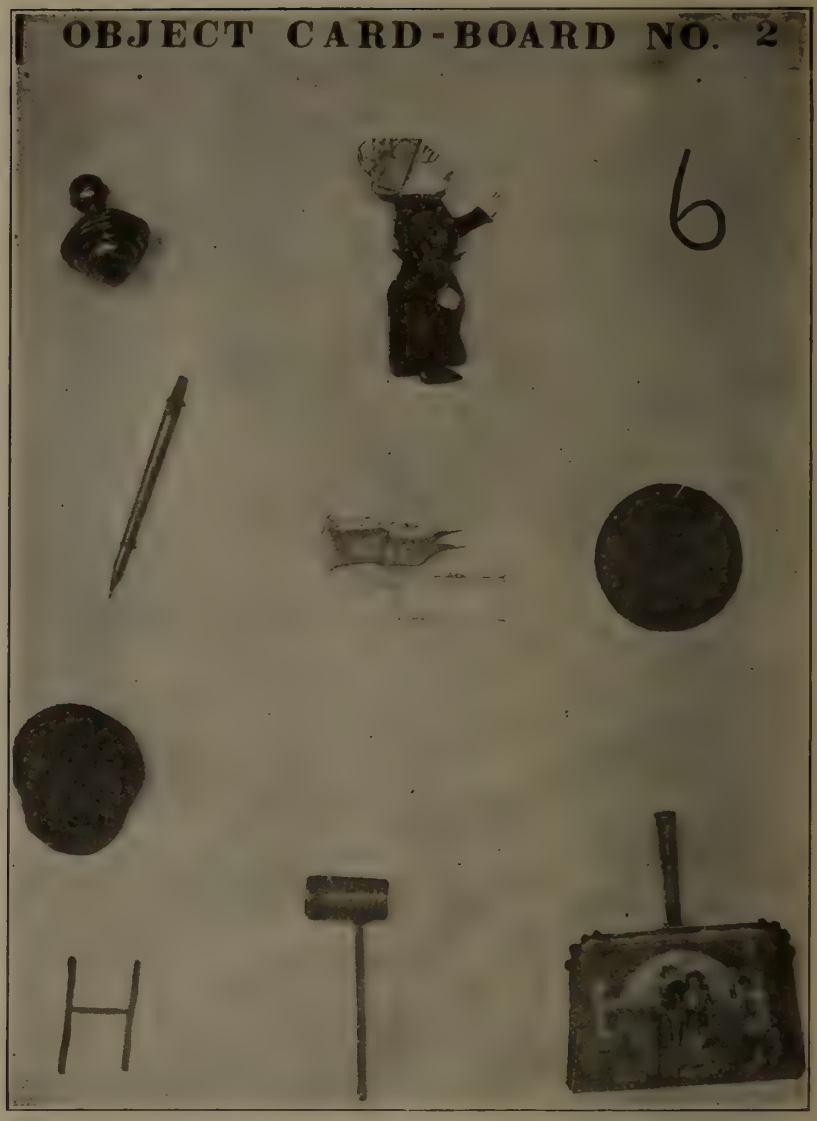
1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

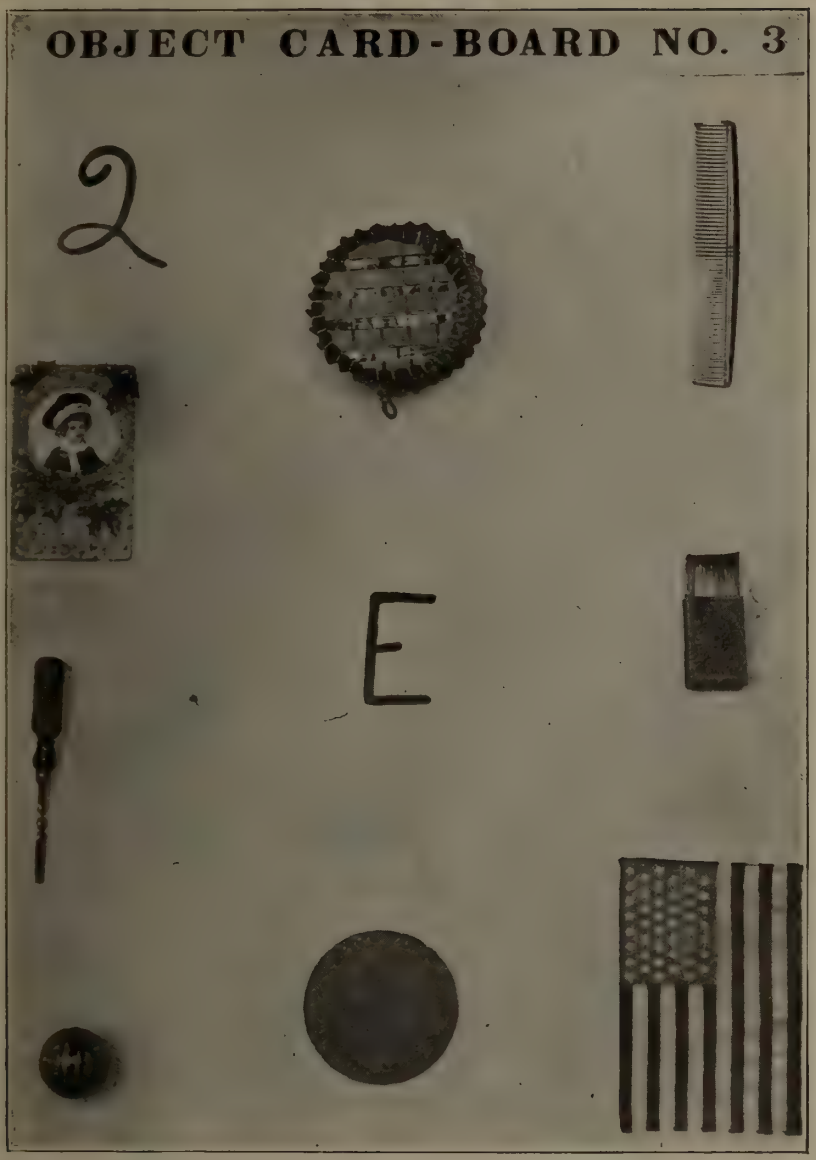
Ten "objects" were placed on each of the five white cardboards, measuring 22 x 28 inches. Each cardboard was surrounded on the reverse side by a wooden frame so as to prevent buckling. The cardboard was supported by the right hand from a cross piece placed horizontally across the middle of the reverse side. A piece of cloth, somewhat longer and wider than the cardboard, was fastened to the top of the frame work. A small wooden rod, about a foot longer than the width of the cardboard, was fastened to the bottom of the cloth. When the cardboard was held before the subjects the cloth shielded all the objects. The exposure of the objects was effected by the experimenter grasping the rod with the left hand and rapidly throwing the screen upward to the reverse side of the cardboard. When the time for the exposure had expired the shield was again jerked rapidly forward over the front of the cardboard. Considerable preliminary practice was engaged in in making exposures, in order to increase the speed of the movement as well as to make the exposure time uniform. It is evident that with the method employed it would be impossible to make the exposures absolutely uniform in length, but the variations were inconsiderable, except in the case of one section each in F1 (normals), F3 (epileptics), and F5 (epileptic girls), where the exposures were slightly lengthened because the cloth caught momentarily when it was being flung back to its original position.

The cardboards contained the following objects:[1]

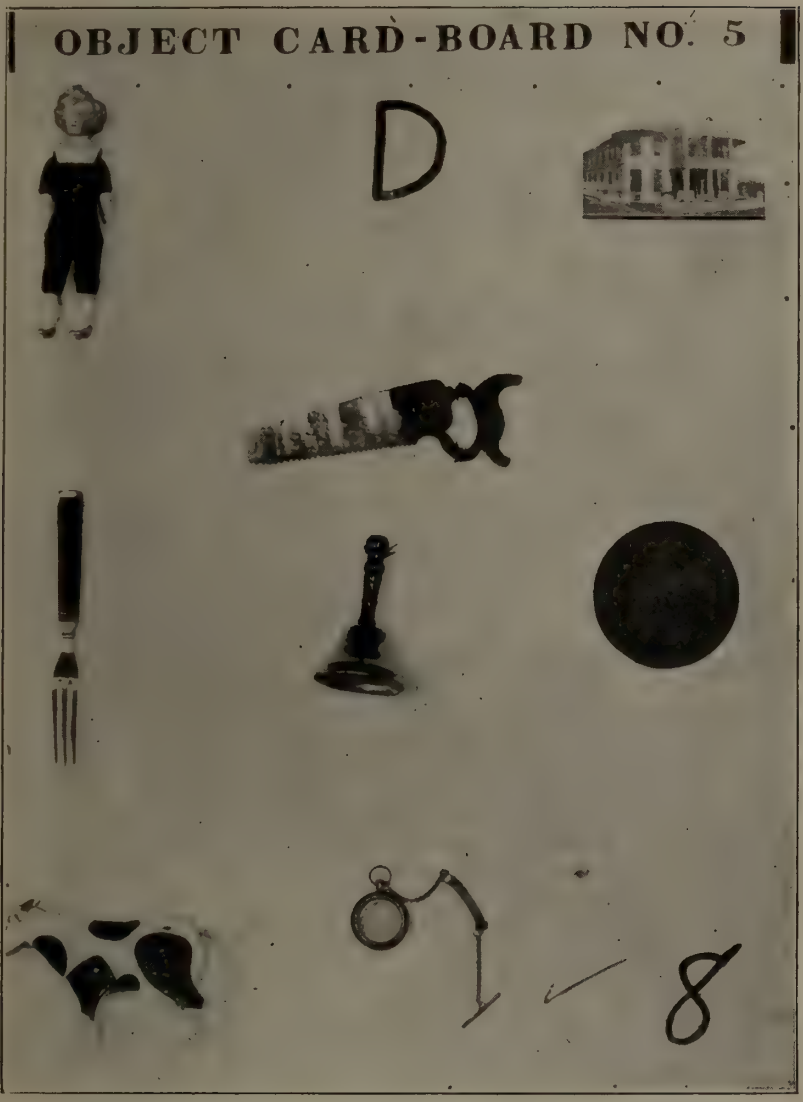
[1]We give these descriptions since these cardboards have not been included in the set prepared by C. H. Stoelting Co.


OBJECT CARD-BOARD NO. 1
C
5


OBJECT CARD-BOARD NO. 2
6
H


OBJECT CARD-BOARD NO. 3
2
E


OBJECT CARD-BOARD NO. 4
9
A



F1: a tree nine inches tall, with green branches, planted in a white tub; a post card with a child in a red suit; a brown bottle, 1¾ x 5 inches; the letter C, 3 inches high; a hatchet with a red blade and black handle, 10½ inches long; a reddish metal rooster, 3 inches high; a spool of black thread, 1¾ inches long; a red disc, 4 inches in diameter; the figure 5, 3 inches high; a shovel, with a black blade, 3 inches long, and a red handle, 8 inches long.

F2: a red top, with green rings, 2½ x 3½ inches; a woman in wood, with red body and white and bluish head, 2½ x 6½ inches; the figure 6, 2¾ inches high; a brown pencil, 6½ inches long; a post card with the word Yale on a blue ground; a black disc, 4 inches in diameter; a black cap, 3 x 4 inches (including the brim in the latter measurement); the capital H, 2 x 3¼ inches high; a yellowish cob pipe, 2¼ x 6 inches; and a tin dust pan with a picture and colored effects in red, blue and yellow, 6¼ x 7¼ inches (including the handle).

F3: the figure 2, 3 inches high; a basket made of green fibre with red edges and bands, 4 inches in diameter; a black comb 1½ x 7 inches; a post card with a child and red and greenish embellishments; a screw driver with a black handle, 6 inches long; the capital E, 3 inches high; a box of safety matches, 1½ x 1¾ inches; a yellow-bluish ball with black band, 1½ inches in diameter; a light green disc, 4 inches in diameter; and a silk U. S. flag, 4¾ x 7 inches.

F4: a black metal horse with red band and golden reins, 3½ x 5 inches; a blue disc, 4 inches in diameter; a red stocking, 1½ x 5¼ inches; the figure 9, 3½ inches long; a red rose, 3¾ inches in diameter; the letter A, 3 inches high; a green metal chair, inclined forward, 3 x 5¼ inches; a horn handled knife, 6 inches long; a post card with the face of a laughing boy, 5½ x 6½ inches; and a black brush, 1 x 7½ inches long.

F5: a doll with a red suit and yellowish hair, 2 x 7 inches; the letter D, 2¾ inches high; a post card with a house in black and white, 3 x 5 inches; a fork with a black handle, 7½ inches long; a saw with a black handle; a nickeled bell with a black handle, 2½ x 4½ inches; a yellow disc, 4 inches in diameter; a wooden cow in white and black, 4 x 6 inches; a gilded watch and chain, the watch being 2¾ inches in diameter; and the figure 8, 2¾ inches high.

It will be observed that each cardboard contains one illustrated post card, one figure, one capital letter, one colored disc (including the black disc), and six solid objects. It was thought that the chances of securing cardboards of equal difficulty would be furthered by this systematic arrangement. But, of course, it would require an extended research to determine whether or not the cardboards are absolutely uniform in difficulty. No objects were selected which were thought not to come within the daily experience of the pupils tested. In order that inequalities might not arise through unequal difficulty in the spelling of the names of the objects in the different sets, the pupils were instructed to make a rapid crude sketch of the objects whose names they were unable to spell. The epileptics and the younger pupils occasionally made such sketches. It was not difficult in the vast majority of the cases to determine from the study of the complete record what the draw-

ings were intended to represent. It was explained that it was only necessary to write the names of the objects, and not a description of each object. Many pupils, however, sometimes wrote brief descriptions, such as a red rooster, a red hatchet, or a spool of black thread. In a few instances the records were slightly inadequate. For example:the colored disc was mentioned usually as a ring, or ball, or spot, but no reference was made to the color. The colored discs were usually referred to as the red (or green, etc.) spot, or red ring, or red circle. The post cards were frequently mentioned without any reference being made as to what was on the cards. Such blanket responses might deserve full credit during the first sitting or two, but hardly thereafter. Again, instead of mentioning the card, merely the picture on the card was referred to, as a girl, a house, or a laughing face. Sometimes only a part of the object was mentioned (e. g., a pot, for the tree in the tub), or one aspect of an object (e. g., brown, for the brown bottle), or a quality was recorded which was found in several objects (e. g., red in F1, which could equally well refer to the red suit worn by the girl on the post card, or the red blade of the hatchet, or the reddish tint on the rooster, or the red disc). In the latter case it was often possible by a process of exclusion to determine just what the recorded quality referred to. Sometimes the objects were misapprehended or misnamed (e. g., the cap was called a hat, the hatchet a hammer). When the misnaming did not seem to be very significant in view of the brevity of the exposure, we felt justified in giving full credit (e. g., for "string" referring to thread or a spool of thread, or "music box" referring to the top). Sometimes the less important part of an object was mentioned (e. g., pot for the tree in F1). It is evident, in view of the many sources of error, that it is no easy matter to make up a list of suitable materials for a test with a very limited time exposure, and that it is not always easy to evaluate the papers. We found it necessary to allow only partial credit for a considerable number of responses. The credits which were given for unusual responses are given in the third section.

All of these objects could be easily seen from any seats in the room which were occupied by the pupils. All the pupils said they had no difficulty in seeing the objects, although we suspected that three or four suffered from imperfect vision to such an extent that they could not clearly see all the objects.

The records were made on blank slips of paper, $4\frac{1}{2}$ x 7 inches.

2. NATURE AND PURPOSE OF THE TEST

This crude tachistoscopic test furnishes a measure of the rapidity or range of visual observation or apprehension during a limited exposure. It must not be forgotten, however, that this trait was not measured in the present test by means of oral responses, but by means of written words or

graphic representations. Some of the pupils, particularly the younger normals and the lower grade epileptics, might have done better if the responses had been oral instead of graphic. Ample time was allowed, however, in which to write the replies. Many of the pupils did not need more than half of the time allowed for the responses.

One of the obvious advantages of this test is its wide range of application, even when the responses are written. The capacity to observe or apprehend develops very early in the life of the child. Any child is able to take the test who can write the names of the objects or make a crude sketch of them. Tests similar to this have frequently been given in the schools with a view to increasing the range of apprehension.

3. DIRECTIONS FOR GIVING THE TEST

Time: Two seconds for the ready signal; five seconds for the exposure; 60 seconds for writing the replies.

Instructions to Pupils: "Beneath this cloth cover you will find a number of things fastened to a white cardboard. I am going to uncover them by lifting the cloth rapidly and throwing it behind this frame. The moment I uncover the objects you must look at them just as carefully and rapidly as possible, for I will only let you look at them a short while. Then when I cover the objects again by jerking the cloth back, you must write down everything that you can remember seeing. You do not need to describe the things that you see, but only write the names of them. If you cannot spell the words or name some of the objects, you can make a simple little picture or a drawing, instead of writing the name. But you must not spend too much time on these drawings. Just make them enough like the thing so that I will know what you mean by them. Now, remember that you must look quickly so you'll see all of the things, and then try to write down everything you saw if you can. But don't write until I say so."

"Now, ready!" (Expose objects and after five seconds say) "Write."

"Now, stop!" "Turn your papers, sign your names."

Ranking: Give 10% credit for every object correctly named. Deductions may be made for the enumeration of wrong objects, but this was not done in this experiment. It was thought that incorrect responses would be sufficiently penalized by the withholding of all credit. It was, however, necessary to give partial credits for answers which were not wholly wrong, or which were only partially satisfactory. As we have already stated, some answers mentioned only one aspect of an object. By a process of exclusion based on the answers given correctly, it was usually possible to determine what objects were referred to by the partly correct answers. But this was

not always the case. The amount of credit which we have allowed for these incomplete answers is confessedly more or less arbitrary. We have in a few cases, taking the brevity of the exposures into account, allowed full credit for responses which were not entirely adequate. It is evident that the proper scoring of the papers was frequently difficult, because of the inadequacy of the replies. It is possible that the replies would have been more adequate had we emphasized more fully that the answers must indicate clearly just what was seen in everything that was on the card. But it is also evident that had we told the subjects that they must state what they might see on the post card or that they must mention the letter or the figure which they might see on the cardboard, we would have suggested the presence of a letter, a figure or a post card on the cardboard. Fortunately some of the partial and unusual responses were only given by one pupil.

The following are the partial credits, or perfect credits for rather inadequate responses, which we have allowed in the different sets:

F1: post card, without mentioning what was on the card, 10%. The same credit was given in F2, but only half credit in the later sets for the same response. Hammer (for hatchet), 8%. Red (for disc), 10%. Brown (for bottle), 3%. Picture (for post card), 10%. Letter (without mentioning C), 3%. Black (for spool, hatchet for shovel), 3%. String or thread (for spool), 10%. Pot or flower (for tree), 5%. Whistle (for rooster), 10%.

F1, reproduced one month later: ring or ball (for red disc), 5%. Doll (for picture on post card), 10%. Card, 10%. Number or letter, without mentioning C or 5, 5%. Green (for tree), 5%.

F2: Doll, or little man, or baby, 10%. Black (for the cap), 3%. Black ball (for black disc), 10%. Circle, 3%. Rattle (for top), 5%. Hat (for cap), 10%. Stick (for pencil), 5%. Flag (for Yale pennant on post card), 10%; Yale (for post card), 10%. Shovel (for dust pan), 10%. Figure (for 6), 3%. Bell (for top), 5%. Picture (for card), 10%. Toy (for top), 3%. Music box (for top), 10%. Whistle, 3%. Red (a number of objects were red), 3%.

F3: Green (for basket or card), 5%. Circle, 3%. Box (for match box), 10%. Picture, 10%. Button hook, or stick of wood (for screw driver), 3%. Chisel, or awl, or tack puller (for screw driver), 10%. Stilleto or dagger (for screw driver), 5%. Girl (on post card), 10%. Post card, 5%. Cloth (for flag), 3%. Top (for ball), 3%. Number (for 2), 3%. Paper cutter (for comb or screw driver), 5%. Green spot or green cloth (for disc), 10%. Red (for either flag or card), 3%.

F3, reproduced one month later: Red (for post card or flag), 3%. Picture, 10%. Circle (for green disc), 3%. Card (for post card), 5%. Number or letter (without mentioning 2 or E), 3%.

F4: Circle (for blue disc), 3%. Blue (for blue disc), 10%. Girl (for boy), 3%. Leg (for stocking), 10%. Arm (for stocking), 5%. Red (for red nose), 3%. Hat (for part of picture on card), 5%. Pink (for stocking), 3%. Black (for brush), 3%.

F5: Red spot or red (for doll), 5%. Round color, or color, 5%. Orange (for disc), 10. Ball (for disc), 3%. Post card, 3% (less credit was given in this sitting for "post card," since the subjects would probably take it for granted that a post card would again be shown). Horse, or donkey, or dog (for cow), 5%. Man (for doll), 5%.

The following data may be separately recorded:

1. Number of *things* named correctly (meaning by "things" everything exclusive of the post cards, figures, letters, and colored disc).

2. Whether the post card was given (if so indicate by a plus sign).

3. Whether the letter was given (indicate by a plus or minus sign).

4. Whether the number was reproduced (indicate by plus or minus).

5. Number of objects or items mentioned which were not on the cards.

6. Whether the colored disc was mentioned (indicate by plus or minus sign).

4. TABLES

TABLE 21

Range of Visual Apprehension: Fl—5

NORMAL CHILDREN

No.	Ae.	Sx.	1/1	2/1	f 2/1	3/1	f 3/2	4/1	f 4/3	5/1	f 5/4	1-2/1	4-5/1	f 4-5/1-2	f 5/1	1-5/1	Gain Ave. 1-5/1
2	7	Boy	20.0	11 5	.57	19 0	1.65	15.0	.79	32.5	1.50	15.7	23 7	1.18	1.12	19.6	3.1
2	7	Girl	45.0	30.0	.75	42.5	1.05	45.0	1 19	39 0	.90	41.8	42 0	.98	.85	42.1	—1.5
4	7	Av.	32.5	17.6	.66	30.7	1.25	30.0	1 05	36 7	1.10	29 7	32.8	1.05	.94	30.8	.8
8	8	Boy	31.2	30.3	98	32.2	1.09	41 8	1.29	38.3	1 05	30.8	38 7	1.36	1 22	34.2	1.8
3	8	Girl	21.0	27.6	1 46	42.0	1.73	29.3	95	35.3	1.36	24.3	33.0	1.30	1 81	31.0	4.4
11	8	Av.	26.4	29.6	1.12	34.9	1.27	38.1	1.19	37.5	1.13	29 0	37 1	1.34	1.38	33.3	2.5
3	9	Boy	30.0	45.0	1.52	39 3	.94	50.0	1.43	46.6	93	33 0	48.3	1.47	1 72	41.0	4.5
4	9	Girl	31.2	31.0	1.03	39.3	.89	40.7	1 56	34.2	93	29 7	37.5	1.50	1 48	34 0	.8
7	9	Av.	30.2	36.6	1.27	39 3	.97	44.7	1.50	39.5	.91	31.2	42.1	1.49	1 58	37.0	2.5
4	10	Boy	32.5	31.6	1 22	46.0	1.27	50.7	1.23	51.2	1.03	32 8	51.0	1.64	1 84	42.5	5.0
1	10	Girl	36 6	41.0	1.14	45.0	1.14	53.3	1 18	39.0	.72	38 8	46.1	1.18	1.06	43.0	5
7	10	Av	34.2	36.3	1.18	45.5	1.20	51.8	1.21	46 0	90	35 4	48.9	1.44	1.51	42 7	3 0
3	11	Boy	40.0	36.6	1.16	53 3	.94	50.0	1 58	54.3	1 09	38.3	52 1	1.42	1.72	42.8	3 5
8	11	Girl	38 5	55.3	1.60	51 3	.95	61.0	1 19	41.5	.79	46 9	54.0	1.15	1 40	50.7	3 0
11	11	Av	38 9	50.0	1 48	46 4	.94	58.0	1 30	49.5	.88	45 5	53 5	1.23	1.49	48.5	3.1
5	12	Boy	40.0	47.2	1.24	47.6	1.06	47.0	.89	47.8	1 19	43 6	45.2	1.04	1.26	45.2	1.9
3	12	Girl	34.3	48.6	1.46	54.3	1.47	45.0	92	61.0	1 56	41.5	53.0	1.38	1.84	48 6	7.5
8	12	Av	37.8	47.7	1 32	50.1	1.21	46.1	90	52.7	1.33	42.8	48.1	1 17	1.48	46 8	4.0
4	13	Boy	53 2	43.3	1 00	48.2	1.03	45.7	.55	50.7	1 10	54.5	48 2	95	97	49.5	.6
2	13	Girl	40.0	50 0	1 25	57.5	1.12	50.0	.90	58.5	1.22	45.0	54 2	1.21	1.46	51 2	4 6
6	13	Av.	48.8	46.6	1 10	51.3	1.06	47.1	.93	53.5	1.14	48 4	50.2	1.04	1 13	49 9	2.0
4	14	Boy	54.5	65.7	1 23	58.7	.92	68.3	1.23	56 6	.78	60 1	62 5	1.04	1.05	60 5	.8
7	14	Girl	45.4	52.2	1.26	47.6	1.05	52.2	.99	50.8	1.06	48.1	51.5	1.08	1.15	49.9	1.7
11	14	Av.	48.7	57.2	1.25	52 5	99	57.1	1 06	52.6	.97	52.5	55.5	1.06	1.11	53.7	1.4
2	15	Boy	70.0	70.0	1.00	70.0	1.00	80 0	1.14	70 0	.87	72.5	75.0	1.57	.99	66 0	0.
2	15	Girl	32.5	62.5	2.36	33.0	.53	52.5	1.58	60.0	1.13	47.5	56 2	1.19	2 30	48.1	3.1
4	15	Av	51.2	65.0	1.90	54.0	.69	66.2	1 26	65 0	1.00	50.0	65 6	1 38	1.65	57.0	1.5
1	16	Boy	60.0	40.0	.66	.....	....	60.0	1.50	63.0	1.05	50.0	61 5	1.23	1.05	55 7	1.0
3	16	Girl	60.0	56.5	1 03	56.0	1.00	58.3	1.06	64.0	1.09	58.8	61 1	1 02	1.09	59 1	1.0
4	16	Av.	60.0	51 0	.90	56.0	1.00	58.7	1.11	63.7	1.08	55.1	61 2	1.07	1.08	58.3	1.0
1	17	Boy	60.0	60.0	1 00	60 0	1.00	70.0	1.16	63 0	.90	60.0	66.5	1.10	1.05	62 6	.7
2	17	Girl	65 0	63.0	.78	69.0	1.22	75.0	1 09	76 5	1.03	64.0	75 7	1.17	1.19	69.8	—1.
3	17	Av.	63.3	61.5	.89	66.0	1.15	73 3	1 11	72 0	.92	62 0	72.6	1.15	1 14	67.4	— .3
Ave. B . . .			41.1	41.3	1.11	43.6	1 06	49.7	1.20	51.6	1.04	41 2	50.7	1 26	1.30	45.5	2.2
Ave. G . . .			40.3	39.5	1 36	48.9	1 10	51.7	1.14	49.7	1.04	39.9	50.7	1.19	1.39	46 1	2.3
Ave. B & G			40.7	40 3	1 25	46.3	1.08	50.8	1.17	50.6	1 04	40.5	50 7	1.23	1.35	45.8	2.3

TABLE 22

Range of Visual Apprehension: F1—5

EPILEPTICS

Su.	Ae.	Sx.	1/	2/	f 2/1	3/	f 3/2	4/	f 4/3	5/	f 5/4	1–2 %	4–5 %	f 4–5/1–2	f 5/1	1–5 %	Gain Ave. 1–5 %
81	10	Boy	20.0	.....	...	...	...	40.0	2.00	40.0	1.00	20.0	40.0	2.00	2.00	33 3	10 0
102	10	Girl	40.0	30.0	.75	20.0	.66	40.0	2.00	50.0	1.25	35 0	45 [illegible]	1 28	1.25	36.0	2.5
104	10	Girl	25.0	30.0	1.20	33 0	1.10	43.0	1.30	30.0	.69	27.5	36 5	1.32	1 20	32.2	1 2
...	Av.	Girl	32.5	30 0	.97	26.5	.88	41.5	1.65	40 0	.97	31.2	40.7	1 30	1 22	34.1	1.8
99	11	Girl	15.0	40.0	2.66	30 0	75	.....		53.0	1 76	27 5	41.5	1.50	1.50	34.5	12.6
79	12	Girl	15.0	20.0	1.33	30 0	1.50	10.0	.33	0.	.00	17.5	5 0	[illegible]	.00	15.0	—3.7
84	12	Boy	50.0	43.0	86	30 0	.69	60 0	2.00	47 0	78	46.5	53.5	1 15	.94	44.0	— .7
91	12	Boy	55 0	60.0	1.09	40 0	66	70.0	1.75	40.0	57	57.5	55.0	.95	.72	53.0	—3.7
...	Av.	Boy	40.0	41.0	1.09	33 3	.91	46.6	1.36	29.0	45	40 5	37.8	.79	.55	37.3	—2.7
108	12	Girl	20.0	20 0	1.00	20.0	1.00	30.0	1.50	15 0	.50	20.0	22 5	1.12	.75	21 0	—1 2
93	13	Boy	20 0	40.0	2.00	23.0	.57	40.0	1 73	43.0	1 07	30.0	41 5	1 38	2.15	33.2	5.7
86	13	Boy	0.	10.0	.....	13.0	1 30	20 0	1.53	10 0	50	5.0	15 0	3.00	....	10.6	2.5
..	Av.	Boy	10.0	25.0	...	18 0	1.43	30 0	1.63	26.5	.78	17 5	28.2	2.19	...	21 9	4.1
97	13	Girl	20.0	33 0	1.65	13 0	.39			20.0	1.54	26.5	16.5	.62	1.00	21.6	0
77	14	Boy	50.0	73.0	1.46	35.0	.47	60.0	1 71	55 0	.91	61.5	57.5	.93	1.10	54 6	1 2
89	14	Boy	30.0	20.0	66	52.0	2.60	30.0	.57	20.0	.66	25.0	25.0	1.00	.66	30.4	—2.5
...	Av.	Boy	40.0	46.5	1.06	43 5	1.53	45.0	1.14	37.5	78	43.2	41.2	.96	.88	42 5	— .6
80	15	Boy	40.0	50.0	1.25	30.0	.60	70.0	2.33	35.0	50	30.0	52.5	1.75	.87	45 0	—1.2
82	15	Boy	20 0	50.0	2 50	50.0	1.00	30 0	.60	53.0	1 76	35.0	41 5	1 18	2 65	50.6	8 2
83	15	Boy	20.0	30.0	1.50	35.0	1 16	30.0	.85	32.0	1 06	25 0	31.0	1.24	1 00	29.4	3.
.	Av	Boy	26.6	43 3	1.75	38 3	.92	43 3	1 26	40 0	1.10	30.0	41.6	1.39	1.70	41 6	3.3
103	15	Girl	10.0	10 0	1.00	10.0	1.00	10.0	1 00	25.0	2.50	10 0	17.5	1.75	2 50	13.0	3.7
78	16	Boy	50.0	43.0	.86	30.0	.60	40 0	1 33	55.0	1 37	46.5	47.5	1.02	1 10	43.6	1.2
88	16	Boy	20.0	50.0	2 50	43 0	.86	50.0	1.16	35.0	.70	35.0	42.5	1 21	1.75	43.6	3.7
85	16	Boy	35.0	50 0	1.42	40.0	.80	40.0	1.00	50.0	1.25	42.5	45 0	1 05	1 42	43 0	3.7
...	Av.	Boy	35.0	47 6	1 59	37.8	.75	43 3	1 16	46 6	1.10	41 3	45.0	1.09	1.42	42.0	2.9
96	16	Girl	0.	10.0		10.0	1.00	0	.00	10.0	...	5.0	5.0	1.00	.....	6 0	2 5
98	16	Girl	40.0	.....	.....	30.0	.75	60.0	2 00	48.0	.80	35 0	54.0	1 54	1 20	44 5	2.6
106	16	Girl	20 0	20.0	1.00	30 0	1.50	40.0	1 33	50.0	1.25	20.0	45.0	2.25	2 50	32.0	7.5
100	16	Girl	40 0	40.0	1.00	40 0	1.00	30.0	.75	32.0	1.06	40.0	31.0	.77	.80	36.4	—2.
....	Av	Girl	25.0	23 3	50	27.5	1.06	32 5	1 02	35 0	1 03	25 0	33 7	1 30	1.50	28 9	2.6
87	17	Boy	15.0	30.0	2.00	30.0	1.00	20.0	.66	20.0	1.00	22.5	20.0	.88	1.33	23.0	1.2
90	17	Boy	10 0	30.0	3.00	25.0	.83	0.	.00	40.0		20 0	20.0	1.00	4.00	21.0	7 5
..	Av.	Boy	12.5	30.0	2.50	27.5	91	10.0	.33	30.0	....	21 3	20.0	.94	2.66	22.0	4.3
95	17	Girl	20.0		.....	13 0	.65	20.0	1 53	15.0	.75	16.5	17 5	1.06	75	17 0	—1.6
105	18	Girl	45.0	30 0	.66	43.0	1.43	10 0	.23	15.0	1.50	37 5	12.5	.33	.33	28.6	—7.5
107	21	Girl	0.	10.0	.....	15.0	1.50	10.0	.66	20.0	2 00	5.0	10.0	2.00	....	11 0	5.
101	24	Girl	30.0	33.0	1.10	30.0	.90	50.0	1.66	20.0	.40	31.5	35 0	1 11	.66	32.6	—2..
Ave. B			28 1	39.9	1.60	33.7	97	38 1	1.22	35 9	.87	33.8	37 0	1 25	1.49	34 1	2.3
Ave. G			23.2	25.5	1.20	24.0	.97	28 6	1 16	28.7	1 23	24.2	26 7	1 26	1.37	25 9	1.5
Ave. B & G			25 8	33.5	1 43	29.0	97	34.0	1.19	32 6	1 04	29.4	33.2	1 25	1.43	30.9	1 9

TABLE 22a

Analysis of the Replies

The different columns contain the following data: 1, the average number of "things" named correctly by each pupil (under things is included everything except the post card, number, letter and colored disc). 2, the average number of mentions per pupil of the post card. 3, the average number of times each pupil mentioned the letter. 4, the average number of times each pupil mentioned the figure. 5, the average number of objects or items mentioned by each pupil which were not on the cardboard. 6, the average number of mentions per pupil of the colored disc.

NORMAL CHILDREN

No.	Ae.	Sx.	JANUARY						FEBRUARY						MARCH						APRIL						MAY					
			1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
2	7	B	1.5	.5	....	....	....	..	1.	....	....	..	..	....	1.	.5	....	5	.5	....	5	.5	....	..	....	.5	2.5	..	.5	....	....	....
2	7	G	2.5	1.	..	.5	.5	.5	3.	....	....	....	..	....	2.	1	.5	.5	1.	.5	2	1.	....	1.	1.	....	2.5	.5	.5	.5	.5	....
4	7	Av.	2.	.7	....	.2	.2	.2	1.6	....	....	....	....	....	1 5	7	.2	.5	.7	2	1.2	.7	....	.5	.5	.2	2.5	.2	.5	.2	....	....
8	8	B	2.2	.6	....	.1	.3	.1	2.1	.1	.1	.5	.3	.2	2.3	.3	.1	.5	1	.1	2 2	.5	.5	.5	.5	.2	3.2	.2	.2	....	.2	....
3	8	G	1.6	.3	.3	....	.3	....	2.3	....	....	.3	.3	....	1.3	.3	.3	6	.3	.6	2.	.3	....	.3	.3	....	3.	.6	.3	....	.3	.3
11	8	Av.	2.0	.5	.09	.09	.3	.09	2.1	.09	.09	.4	.3	.09	1.	.3	.1	.5	.2	.2	2.	.5	.4	.5	.4	.3	3.2	.3	.2	....	.2	.09
3	9	B	2.6	.3	..	....	..	....	2.5	1.	.5	....	..	....	4.5	.3	....	.3	.6	.3	3.6	.6	.3	.3	.3	....	3.6	.6	.3	.3	1.	.
4	9	G	1.7	1.	....	.2	..	.2	1.6	.3	.3	....	....	.3	2.6	.	.6	.6	.6	.6	3.	.7	.2	....	....	.2	2.5	.5	.2	.2	....	....
7	9	Av.	2 1	.7	....	.1	.	.1	2.0	.6	.4	.5	....	.1	3.4	.2	.4	6	.6	.5	3.3	.7	.2	.1	.3	.2	3.	.5	.3	.2	.5	....
4	10	B	2.7	.5	..	....	..	..	2.6	.3	....	....	....	.3	2.3	.3	.3	1.	1.3	.3	2.5	.7	.7	1	.5	.5	3.2	.7	.5	.2	.5	.2
3	10	G	2.3	.6	....	.3	.3	.3	2.6	6	.3	.3	....	.3	2.3	.6	.6	6	....	.3	4.	1.	....	.3	.6	....	2.6	1.	....	.3	....	....
7	10	Av.	2.5	.5	....	.1	1	.1	2 6	.5	.1	.1	....	.3	2.3	.5	.5	.8	.6	.3	3 1	.8	.4	.7	.5	.2	3.	.8	.2	.2	.2	.1
3	11	B	2.3	.3	.3	.3	1.	....	2.6	.3	.09	.3	....	....	2.	....	.6	.3	1.3	.3	3.3	1	.3	.3	....	....	3.6	.3	.6	.3	.3	.3
8	11	G	2.	.6	....	..	....	.3	3.2	.7	.3	.7	.1	.3	3.2	.3	.3	.8	.1	.5	2.3	.8	.7	.7	....	.6	3.	.7	.7	.3	.2	....
11	11	Av.	2.1	.5	.09	.2	....	.2	3 0	.6	.3	.6	.09	.2	3.0	.2	.4	.7	.4	.5	3.2	.9	.6	.6	....	.4	3.2	.6	.7	.3	.3	....
5	12	B	2.8	.6	..	.2	....	.4	3.2	.6	....	.2	.2	.6	2.8	.6	....	1.	.2	.6	3.7	.7	....	....	.2	.5	3.4	.8	.6	.2	..	.2
3	12	G	2.3	.6	....	.3	1.	.3	3.3	1.	....	....	.6	.3	3.6	1.	.3	.6	.3	.6	2.6	1.	....	....	.6	1.	4.	.6	.6	.3	..	....
8	12	Av.	2.6	.6	..	.2	.3	.3	3.2	.7	....	.1	.3	.5	3.1	.7	.1	.8	.2	.6	3.2	.8	....	....	.4	.4	3.6	.7	.6	.2	..	.1
4	13	B	3.2	.5	.5	.2	.7	.7	3.3	.3	....	....	1.	.3	3.7	.2	..	.5	.5	.6	2.0	.7	.5	.7	1.2	.5	3.	.7	.5	.5	.2	.2
3	13	G	3.	.5	.5	....	....	....	3.5	.5	.5	....	....	.6	4.0	1.	..	.5	....	.5	4.	1.	....	....	....	....	4.5	1.	.5	....	....	.5
7	13	Av.	3.1	.5	.5	1	5	5	3.4	.4	.2	....	.2	.4	3.8	.5	....	.5	3	.5	2.6	.8	.3	.4	.8	.3	3.5	.8	.5	.3	1	.3
4	14	B	3 2	1.	.2	.2	..	.7	4.7	.7	.5	....	.2	.7	3.2	.7	.5	.7	.2	.5	4.3	.7	.3	.6	.3	.3	3.6	.6	....	.6	....	.3
7	14	G	2.5	.7	.4	.2	.2	....	3 6	.4	....	.8	....	.4	3.	.6	.6	.6	....	.2	2.9	.8	.5	5	.4	.2	3.5	.7	.5	.2	.2	.2
11	14	Av.	2.8	.8	.3	.2	.1	.2	4.1	.5	.1	.5	.1	.5	3.1	.6	.5	.6	.1	.3	3.3	.8	.5	.6	.4	.3	3.6	.7	.4	.4	.2	.3
2	15	B	3.5	1.	1.	.5	....	1.	2.	.5	.5	....	....	.5	4.	....	1.	....	....	1.	4.5	1.	.5	1	....	1.	2.	1.	.5	1	....	.5
2	15	G	2.5	.5	5	....	....	.5	3.5	1.	.5	.5	....	1	2.5	....	.5	.5	.5	.5	3.	1.	....	1.	1.5	.5	2.5	1.	1.	.5	.5	1.
4	15	Av.	3.	.7	.7	.2	....	.7	2.7	.7	.5	.2	....	.7	3.	....	.6	.3	.3	.6	3.7	1	.2	1.	.7	.7	2.2	1.	.7	.7	.2	.7
1	16	B	6.	....	....	....	....	....	3.	....	....	1.	....	....	....	....	....	....	....	....	5.	....	..	..	..	..	4.	1.	1.	....	....	....
3	16	G	3 3	.6	.6	6	.3	.6	4 5	..	1	.5	....	..	3.	.6	.6	.6	..	.6	4.	.6	....	6	..	.3	4.0	1.	.3	.6	1.3	.6
4	16	Av.	4.	.5	.5	.6	.2	5	4.	....	.6	.6	....	..	3.	.6	.6	.6	..	.6	4.2	.6	....	.5	....	.2	4.	1.	.5	.5	1.	.5
1	17	B	4.	1.	1.	....	....	....	4	1.	.	....	....	1.	6.	....	....	....	....	....	5.	1.	....	1.	....	1.	4.	....	....	1.	....	....
2	17	G	4.5	1.	1.	..	....	.5	3.	1.	....	....	....	1.	4.	1.	1.	1.	....	.5	5.	1.	.5	.5	1.	.5	4.5	1.	.5	1.	..	.5
3	17	Av.	4.3	1.	6.	....	..	.3	3.5	1.	....	....	....	1.	4.6	.6	.6	.6	....	.3	5.	1.	.3	.6	.3	.3	4.2	.6	.3	1.	....	.3
Ave	Boys		2.8	.5	.1	.2	.1	.3	2.8	.4	1	.2	.1	.3	2.8	.3	.2	.5	.4	.3	3.0	.7	.3	.5	.4	.3	3.2	.5	.4	.3	.2	.2
Ave.	Girls		2.6	.7	.2	.2	.2	.2	3.	.5	.2	.4	.08	.3	2.7	.5	.4	.6	.2	.5	3.1	.8	.3	.4	.3	.3	3.3	.7	.5	.3	.2	.1
Ave	Boys and Girls		2.7	.6	2	.2	.2	.3	2.9	4	.2	.3	.1	.3	2.7	.4	.3	.6	.3	.4	3.1	.7	.3	.5	.3	.3	3.2	.6	.4	.3	.2	.2

TABLE 23

Explanations as in Table 22a. Only the figures at the bottom of the table are averages.

EPILEPTICS

Su.	Ae.	Sx.	JANUARY						FEBRUARY						MARCH						APRIL						MAY					
			1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
81	10	Boy	2.	...	.	..	....	..	..	...	....	.	..	.		..	...	..	....	..	3.	1.	....	...	....	....	2.	1.	1.	...	....	...
102	10	Girl	4.	...	.	..	....	..	3.	...	....	.	..	.	2.	..	...	..	....	..	3.	1.	....	...	....	....	4.	1.	....	....	....	....
104	10	Girl	2	...	.	....	....	....	3.	...	....	....	..	..	3.	....	....	....	....	..	3.	..	....	1.	....	....	2.	1.	....	....	....	....
	Ave.	Girl	3.	...	.	....	....	..	3.	...	....	....	....	....	2.5	....	....	....	....	....	3.	.5	....	.5	....	....	3.	1.	....	....	....	....
99	11	Girl	2	...	.	..	....	..	4.	...	....	....	....	....	3.	....	....	....	1.	....	....	....	1.	....	....	....	4.	....	....	1.	2.	....
79	12	Boy	2	...	.	..	....	..	2.	...	....	....	....	....	2.	....	....	....	....	....	....	....	....	....	....	....	0.	....	....	....	....	....
84	12	Boy	3.	1.	1.	....	....	..	3.	...	..	1.	..	....	2.	....	....	1.	1.	..	4.	1.	....	.	..	1.	3.	1.	....	....	....	1.
91	12	Boy	6	...	.	..	....	..	6.	...	....	....	....	....	4.	....	....	....	....	..	6.	1.	....	....	....	....	3.	1.	....	....	....	....
	Ave.	Boy	3.6	.3	.3	....	....	....	3.6	..	.	.3	....	....	2.6	.	.	.3	.3	....	5.	1.	....	....	..	.3	3.	.6	....	....	..	.3
108	12	Girl	2.	...	.	..	....	....	2.	...	....	....	....	....	2.	.	.	....	....	....	2.	..	....	....	....	....	....	....	....	....	2.	...
93	13	Boy	2.	...	...	....	1.	....	4.	...	....	....	....	..	3.	....	....	....	....	....	4.	....	....	....	....	....	2.	1.	....	1.	....	....
86	13	Boy	...	...	.	....	....	....	1.	...	....	....	....	....	1.	....	....	....	....	....	1.	1.	....	....	....	....	....	1.	....	....	....	....
97	13	Boy	2.	...	.	...	1.	...	3.	...	....	..	1.	....	1.	....	....	....	....	....	....	....	....	....	....	....	2.	....	....	....	....	....
	Ave.	Boy	1.3	...	.	..	.6	..	2.6	...	....	....	.3	..	1.6	....	....	....	....	....	3.	.3	....	....	....	....	2.	.6	..	.3	.3	..
77	14	Boy	3.	1	...	..	.	1.	5.	1.	1.	....	....	....	4.	1.	..	....	....	....	3.	1.	1.	1.	..	....	6.	....	....	..	1.	....
89	14	Boy	2	1.	...	..	....	....	2.	...	....	....	....	....	3.	1.	..	1.	....	....	2.	....	....	....	....	1.	1.	1.	....	....	....	....
	Ave.	Boy	2.5	1.	...	....	....	.5	3.5	.5	5.	..	....	..	3.5	1.	....	.5	....	....	2.5	5	.5	.5	....	.5	3.5	.5	....	....	.5	....
80	15	Boy	2.	1.	...	....	....	1.	4.	...	1.	....	..	..	2.	....	....	1.	....	....	4.	....	....	1.	..	1.	4.	....	....	1.	..	..
82	15	Boy	1.	1.	.	....	.	..	3.	1.	....	..	..	1...	3.	1.	....	1.	..	..	1.	1.	....	..	1.	1.	4.	1.	....	....	....	....
83	15	Boy	2.	...	...	....	..	..	3.	...	....	....	....	....	3.	1.	....	....	....	....	3.	....	....	....	....	....	3.	1.	....	....	....	....
	Ave.	Boy	1 6	.6	..	....	..	.3	3.3	..	..	..	..	..	2.6	.6	..	.6	..	..	2.6	.3	..	.3	.3	.6	3.6	.6	....	..	.3	....
103	15	Girl	1.	...	.	....	..	..	.	1.	.	..	..	..		..	..	..	..	..	1.	....	....	....	....	....	2.	....	....	....	....	....
78	16	Boy	4.	1.	.	....	....	..	3.	...	...	1.	....	....	2.	...	..	1.	....	....	3.	....	....	1.	....	....	5.	1.	....	....	....	....
88	16	Boy	1.	1.	.	....	....	..	5.	...	....	....	....	....	3.	...	....	....	....	....	2.	1.	1.	1.	....	....	3.	1.	....	....	....	....
85	16	Boy	3.	1.	.	....	....	....	5.	...	....	....	....	....	4.	....	....	....	1.	..	3.	1.	....	....	....	....	5.	....	....	....	....	....
	Ave.	Boy	2 6	.	..	....	....	....	3.2	...	....	....	....	....	....	....	....	....	....	..	3.6	.6	.3	.6	....	....	4.3	.6	..	....	....	....
96	16	Girl	.	...	.	..	....	..	1.	...	....	....	....	....	1.	...	..	....	....	....	..	....	....	....	....	....	1.	....	....	....	1.	....
98	16	Girl	4.	...	.	..	1.	.	.	...	....	....	....	....	2.	..	....	....	....	....	5.	....	....	....	1.	....	4.	1.	....	....	1.	....
106	16	Girl	2	...	.	....	..	..	1.	1.	....	....	....	....	3.	1.	....	....	....	....	3.	1.	....	....	....	....	3.	1.	....	1.	1.	....
100	16	Girl	4	...	.	....	....	....	3.	1.	.	....	....	....	2.	1.	..	1.	1.	..	2.	1.	..	..	2.	....	3.	1.	....	....	....	....
	Ave.	Girl	2 5	...	.	....	.2	....	1.6	...	.	....	....	....	2.	.2	....	.2	....	....	2.5	.5	....	....	.7	....	2.7	.7	....	.2	1.	....
87	17	Boy	2.	...	.	....	....	..	3.	...	....	....	....	....	2.	1.	....	....	....	....	1.	1.	....	....	....	....	2.	....	....	....	....	....
90	17	Boy	2	...	.	....	....	..	3.	...	....	....	....	....	2.	1.	....	....	....	....	....	....	....	....	....	....	4.	....	....	....	....	....
	Ave.	Boy	2.	..	...	....	....	....	3.	...	....	....	....	....	2.	1.	....	....	....	....	.5	.5	....	....	....	....	3.	....	....	....	....	....
95	17	Girl	2.	.	.	....	....	....	.	...	....	....	....	....	1.	....	....	....	....	....	....	1.	....	....	....	....	2.	....	....	....	....	....
105	18	Girl	4	.	.	..	..	..	3.	...	....	....	....	....	1.	1.	1.	1.	....	....	1.	....	....	....	....	....	2.	....	....	....	....	....
107	21	Girl	.	.	.	....	....	....	1.	...	....	....	....	....	1.	....	....	....	....	....	1.	....	....	....	1.	....	2.	....	....	....	....	....
101	24	Girl	3.	...	.	....	....	....	2.	...	....	....	....	....	1.	1.	....	....	1.	....	3.	1	....	1.	....	....	2.	....	....	....	....	....
Ave. Boys			2 3	4	.05	....	.1	.1	2.9	.3	.1	.1	....	.05	2.5	.3	....	.3	.1	..	2.5	.5	.1	.2	.05	.2	3.4	.6	.05	.05	.1	....
Ave. Girls			2.3				.07		2.0	.1	....				2	.2	.08	.1	.2	....	2	.5		.1	.3	....	1.7	.3	....	.15	.6	.05
Ave. Boys and Girls			2.3	.2	.03	....	.1	.06	2.5	.2	.07	.07	....	.63	2.3	.3	.03	.2	.1	..	2.2	.5	.07	.2	.1	.1	2.4	.5	.03	.10	.3	.03

5. RESULTS (See Tables 20, 21, 22a, and 23)

IMMEDIATE RECALL

COMPARATIVE EFFICIENCY

The average efficiency for all the normals in all the five sittings (next to the last columns in the tables) was 45.8% and for the epileptics 30.9%. The normals were able to give not quite one-half of the objects and the epileptics not quite a third. The epileptics' comparative efficiency amounted to 67% of the normals. The average for the epileptics was the same as for the youngest normals, the seven-year-olds, and only 46% as good as for the oldest group of normals.

The boys' capacity in this test, based on the general average for all five sittings (given at the bottom of the next to the last column), amounted to 98% of the girls' capacity among the normals, while the girls' capacity among the epileptics amounted to only 73% of the boys'. Based on the sex averages for each sitting (at the bottom of the columns), the normal boys did better than the normal girls in three sittings and poorer in two sittings, while the epileptic girls did poorer in all of the five sittings. Based on the sex averages in the different ages for sittings 1 to 5, the normal girls surpassed the normal boys in seven ages, while the boys surpassed the girls in four ages. With the epileptics the boys excelled in five ages and the girls in one, no comparison being possible in the remaining ages.

The power of observation, as measured by this test, improves uniformly from age to age. Based on the averages for the two sexes for sittings 1 to 5, there is an improvement among the normal children in all the ages except one, namely age 12, in which there is a slight loss. In this age, however, only 62% of the pupils were classed as average and dull, against 72% in age 11. The difference between the averages for the youngest (who made the lowest score) and oldest subjects (who made the highest score) amounts to 36.6% (67.4%–30.8%). There is no consistent gain with increasing chronological age among the epileptics.

Not a single epileptic failed to score in all the sittings, while only one failed in two sittings (in each case she had a convulsion before the test was given) and four failed in one sitting. One of the latter was incapacitated by a convulsion a short time before the test was given, and one was below normal on this day. One of the normal pupils failed to make a score in all five sittings (No. 5, the "dull" seven-year-old boy in the second grade), and one failed in one sitting (an "average" 8-year-old boy in the second grade).

The normals and the epileptics made their highest averages in the fourth sitting, while the normals made their lowest average in the second sitting and the epileptics in the first.

COMPARATIVE IMPROVEMENT

The average monthly gain made by each subject during the five sittings (last column in the tables)amounted, in absolute units, to 2.3% for the normals and 1.9% for the epileptics. The epileptics improved 82% as much as the normals did. Based, however, on the index of improvement, which gives the amount of improvement relative to the size of the average score, the epileptics gained more on their own records than did the normals on their records. This is seen from the following percentages of improvement of the second sitting compared with the first, of the third compared with the second, etc. (based on the indices at the bottom of the table):

	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$	$\frac{5}{1}$	$\frac{4-5}{1-2}$
Normals	25%	8%	17%	4%	35%	23%
Epileptics	43%	–3%	19%	4%	43%	25%

The difference in favor of the epileptics amounts to 18% in the second sitting compared with the first, 2% in the fourth compared with the third, 8% in the fifth compared with the first, and 2% in the average of the fourth and fifth compared with the average of the first and second. On the other hand, the normals gained 11% more than the epileptics in the third sitting compared with the second, while the relative improvement is the same in the fourth sitting compared with the third.

The only loss, according to the indices of improvement, was made by the epileptics in the third sitting compared with the second. If we turn to the figures at the foot of the columns in the tables containing the percentage scores, both the epileptics and the normals lost in two of the successive sittings, while they gained in two. (Strangely, the epileptics lost in both of the sittings in which the exposures were made somewhat too long in one section.) The discrepancy between the gain according to the index and loss according to the score in the second sitting for the normals, is accounted for by the fact that the total in column 1 is divided by more than the totals in columns 2 and $f\frac{2}{1}$, because of the absence of six subjects in the second sitting.

Based on the results in the column containing the average monthly gain for sittings 1 to 5, one epileptic made no improvement while ten showed losses, which is 36% of all the epileptics. On the other hand, nine normals made no gains while nineteen lost, which is the same percentage for the normals.

The absolute monthly gain for the five sittings was about the same for the normal boys as for the normal girls (2.2% vs. 2.3%), but almost one and two-thirds times larger for the normal boys than for the normal girls (2.3% vs. 1.5%). Based on the average indices of improvement at the foot of the index columns, the normal girls gained more than the normal boys in the second and third sittings, and in the fifth compared with the first, the boys gained more in the fourth sitting and in $\frac{4-5}{1-2}$, while the improvement was equal in the

fifth sitting compared with the fourth. The epileptic girls gained more than the epileptic boys in the fifth sitting and in $\frac{4-5}{1-2}$, the boys gained more in the second, fourth and fifth compared with the first, while the losses are the same in the third sitting. The gain in the fifth sitting over the first was 9% more for the normal girls than for the normal boys (39% vs. 30%), and 12% more for the epileptic boys than for the epileptic girls (49% vs. 37%). The gain based on the average of the last two sittings compared with the average of the first two ($f \frac{4-5}{1-2}$) was 7% more for the normal boys than for the normal girls (26% vs. 19%), but 1% more for the epileptic girls than for the epileptic boys (26% vs. 25%).

When the gain in each age is compared with the gain in the next following age, the amount of the improvement, based on the average monthly gain in the last column, among the normal pupils increases in five ages, decreases in four, while there is one instance in which the gains are equal. Based on the index $f \frac{4-5}{1-2}$, there is an increase in five ascending ages and a decrease in five. The corresponding results for the epileptics are very irregular.

ANALYSIS OF DATA

In Tables 22a and 23 we have made an analysis of the replies in each sitting, in order to determine which types of presentation (the letters, figures, post cards, colored discs, or objects, which we refer to as "things") were the most easily noticed or recalled. This tabulation, unfortunately, is not absolutely accurate. Thus we restricted the use of the category "things" to everything on the cardboards except the post card, number, letter and colored disc. One of the two teachers, however, who helped us to analyze the data classified the post cards as things. She did not analyze many of the papers. It was impossible to correct this mistake, because we did not learn of it until the original data were inaccessible (they were left at the New Jersey State Village for Epileptics). Again, we are not absolutely certain that this assistant properly recorded the answers relating to the post cards, letters or numbers. These were to be scored as plus (or as "mentioned") only provided the illustration was mentioned on the card, and only provided the particular letters and numbers shown were correctly designated. It is possible that the assistant recorded plus for general answers like "post card," "letter," and "number." Owing to the inaccessibility of the original data and the inability to reach the assistant in question we cannot definitely settle this point. Moreover, it has frequently been very difficult to rule that some things which were mentioned were not on the cardboard, because the "things" mentioned could sometimes be regarded as aspects of some of the objects which were actually on the cardboards. In presenting the data we desire to call attention to these unremovable defects. We shall refer merely to the gross results.

The average number of "things" correctly mentioned was as follows for each of the normal children in the five successive groups: 2.7, 2.9, 2.7, 3.1 and 3.2. For the epileptics the corresponding figures are: 2.3, 2.5, 2.3, 2.2 and 2.4. It will be noticed that the normal children were able to name, on the whole, only about one-half of the "things" (of which there were six on each card), while the epileptics named less than one-half.

The average number of mentions made of the post cards by each normal pupil is as follows in each of the five successive sittings: .6, .4, .4, .7 and .6. The corresponding figures for the epileptics are: .2, .2, .3, .5 and .5. Taken all in all, about one-half of the normal pupils mentioned the post card and only about one-third of the epileptics. The epileptics, however, did almost as well as the normals in the last two sittings. Full credit was given for some responses which might be considered slightly inadequate, such as "picture," flag (F2), man's hat (F4), and book with girl (F3).

The average number of mentions per normal pupil of the letters is as follows in the five successive sittings: .2, .2, .3. .3 and .4. The corresponding figures for the epileptics are .03, .07, .03, .07 and .03. Less than one-third of the normal pupils, except in one sitting, mentioned the letters, while the number of epileptics who mentioned them is negligible.

The average number of times that each normal pupil mentioned the numbers is as follows in each of the five successive sittings: .2, .3, .6, .5 and .3. For the epileptics the figures are .0, .07, .2. .2 and .10. On the average, a little over one-third of the normal pupils mentioned the numbers, while only one-fifth of the epileptics mentioned the numbers in the two sittings in which they made the best record.

The average number of mentions per normal pupil of the colored discs is as follows for the five successive sittings: .3, .3, .4, .3 and .2. The corresponding figures for the epileptics are .06, .03, .0, .1 and .03. In general, less than one-third of the normal pupils mentioned the colored disc and only a negligible number of the epileptics. It should be mentioned that in tabulating the results for the colored disc no credit was given a considerable number of indefinite or incomplete responses which, no doubt, frequently referred to the colored discs. Thus no credit was given the following responses among the normals. In F2: circles (6 times); black objects (twice). In F3: ring (once). In F4: circle (once) and red circle (once). In F5: ball (three times); circle (3 times), red circle or red sphere (twice each). Among the epileptics the following were not credited in F5: ball (2 times); O with no color indicated (twice). On the other hand, the following indefinite responses from the normals were credited as correct: In F2, black (3 times). In F3, green (6 times, although there were other greenish objects on the cardboard). In F4, blue (7 times). In F5, yellow (once). For the epileptics the following was given credit: in F5, orange.

Comparing the above results, we may conclude that "things" were the most readily recalled by both groups (in harmony with an earlier finding in which the memory of things was compared with the memory of words), while the post cards were almost as frequently recalled by the normal pupils. The letters, numbers and colored discs were recalled about equally easily, but they were distinctly more difficult of recall than the things or post cards, more particularly so for the epileptics. The letters and numbers probably attracted less attention than the objects, because they were inherently less attractive and smaller. The colored discs, however, were as large as many of the "things" and some of the colors were quite bright.

The average number of objects mentioned by each normal pupil which were not on the cardboards is as follows for each of the five successive sittings: .2, .1, .3, .3 and .2. For the epileptics the figures are: .1, .0, .1, .1 and .1. The number of wrong objects mentioned averages less than one-third of an object for each normal child, and only about one-tenth of one object for each of the epileptics. The reason that the epileptics made less mistakes is not due to the fact that they were keener observers, but to the fact that they made fewer responses than the normal children and responded merely to objects as a whole.

The number of errors does not seem large, considering the brevity of the exposure. It should be explained, however, that we allowed credit for responses that were not strictly correct. Thus the following responses were considered to be adequate, in the sense that what was mentioned was considered to be on the cardboards: F1, normals, coat (for the child on the post card), wood (for the hatchet or tub of tree), and pink (for the reddish rooster). F2, normals: orange (for the yellowish pipe, or the yellowish tint on the dust pan), white (for the white face on the woman), brown (for the brownish pencil), green (for the green ring on the top), and purple (for the blue on the dust pan or on the woman). F2, epileptics: wood (for the woman). F3, normals: black (for the black comb), and file and nail file (for the comb). F4, normals: red (three times, for the red stockings), white (twice, for the white post card), green (for the green chair), wire (for the wire chair), black (for the horse), yellow (for the golden reins). F5, normals: baby (twice), boy (three times, for the doll), wood (for the wooden cow), white and black (for the white and black cow), horse (10 times), donkey (five times), and dog (three times—for the cow), brass or iron (for one of the metallic objects), yellow (for the yellowish hair on the doll or the watch and chain), eyes, or nose, or mouth or feet (for parts of the doll), tail (for the tail of the cow), and gilt (for the gilded watch and chain). F5, epileptics: horse (five times, for the cow), and boy (twice, for the doll).

Among the objects which were incorrectly given are the following: F1, normals: watch, "wash," flag, "gut," cake, box, blue, and eight other ob-

jects the names of which cannot be given because of the inaccessibility of the original data. F1, epileptics: dog, "catch," and one other object. F2, normals: horse, wax, brush, pit, apron, pot, "fore board," coal, C, and D. F3, normals: top (twice), bottle, brush, hatchet, ribbon, thread, spool of thread, rattle, pencil, nail file, file, pencil, knife (four times), C, "Ch," "red eb" and seven other objects. F3, epileptics: knife, man, "three," 4 and tree. F4, normals: ball (six times), scissors (twice), oval, dog, B, E, M, 1, 3, bath tub, green sphere, pen, ball, ring, cup, bug, orange, "fall," "a bug," and seven others. F4, epileptics: washstand, red ball, dog, lady and girl. F5, normals: knife (four times), man (twice), red ring (twice), scissors (twice), ball, glass, hammer, brush, "forty," scenery, chair, hatchet, top, E, and two other objects. F5, epileptics: ribbon, ball, hut, cat, clown, knife, scissors, and "frick ball."

DEFERRED RECALL

Retention of Objects after an Interval of One Month

Without warning, the subjects were asked in the February sitting before F2 was given to write down all the objects which they could recall from F1, which was shown one month earlier. In April they were similarly asked to make out a written list of the objects shown in March. The time allowed for writing was the same as in the original tests, 60 seconds.

TABLE 24

Range of Apprehension after the Lapse of One-Month: January (F1) in February; March (F3) in April.

Normal Children						Epileptics					
No.	Age.	Sex.	F 1	F 3	Ave.	Su.	Age.	Sex.	F 1	F 3	Ave.
			%	%	%				%	%	%
2	7	Boy	25.	6.5	17.1	81	10	Boy	..	....	.....
2	7	Girl	30.	20.	27.	102	10	Girl	0	10	5.
4	7	Ave.	26.6	13 2	24.1	104	10	Girl	10	10	10.
3	8	Boy	15.7	9.7	12.7	99	11	Girl	10		10.[1]
3	8	Girl	10.	2.5	6.2	79	12	Boy	0	20	10.
11	8	Ave.	14.4	8 1	11.3	84	12	Boy	40	15	27 5
3	9	Boy	22.5	10	18.7	91	12	Boy	20	15	17.5
1	9	Girl	23.7	9 5	16 6	108	12	Girl	10	0	5.
7	9	Ave.	23.3	9.7	17.3	93	13	Boy	10	10	10.
4	10	Boy	26.6	9.5	15.3	86	13	Boy	20	0	10
3	10	Girl	33.3	11.6	22.5	97	13	Girl	0	....	0.
7	10	Ave.	30.	10.4	19.1	77	14	Boy	45	18	31.5
3	11	Boy	36.6	0	25.	89	14	Boy	0	0	0.
8	11	Girl	45.	23.5	34.5	80	15	Boy	25	10	17 5
11	11	Ave.	42.7	18 8	32 4	82	15	Boy	30	5	17.5
5	12	Boy	28.	15.7	21 6	83	15	Boy	20	10	15.0
3	12	Girl	37.6	23.3	30.5	103	15	Girl	0	0	0
8	12	Ave.	31.2	19.	25.4	78	16	Boy	20		20.[1]
4	13	Boy	35.	15	24.1	88	16	Boy	15	20	17.5
2	13	Girl	40.	25.	32.5	85	16	Boy	25	5	15.0
6	13	Ave.	37.	22	27.5	96	16	Girl	0	0	0.
1	14	Boy	56 6	11 6	34.1	98	16	Girl		10	10.[1]
7	14	Girl	40	10.7	25 3	106	16	Girl	10	10	10.
11	14	Ave	43.2	11.	28.	100	16	Girl	20	10	15.
2	15	Boy	45	5.	23.7	87	17	Boy	0	0	0.
2	15	Girl	31.5	0	15.7	90	17	Boy	0	0	0.
4	15	Ave.	38.3	1.6	19.8	95	17	Girl	0	0	0.
1	16	Boy	35.	3.	19.	105	18	Girl	0	0	0.
3	16	Girl	55	26 6	42.5	107	21	Girl	10	0	5.
4	16	Ave.	48 3	20.7	34.6	101	24	Girl	0	10	5.
1	17	Boy	25.	0.	12.5	.....	..	....	.....	....	.....
2	17	Girl	40.	30.	32.5	....	....	.. ...	....	... ..	.....
3	17	Ave.	32.5	20	22.5	....	.....	.....	.....	.....	....
Ave. Boys			30.0	9 8	19.9	Ave. Boys.....			18	9.1	13.3
Ave. Girls			36.8	16.8	26.4	Ave. Girls			6.1	5.0	5.2
Ave. Boys and Girls..			33.6	13.6	23.4	Ave. Boys and Girls....			12.1	7.2	9.7

[1]No figures are available for averaging these

The average of F1 and F3 for the normals is 23.4%, Table 24, which is about 53% of the average score made in the immediate recall of the same sets. The corresponding figure for the epileptics is 9.7%, which is only 35% of the original average (approximate). The epileptics' degree of inferiority, relatively to the normals, was greater in the deferred than in the immediate recall. In the immediate reproduction of F1 and F3 (using approximate averages), the epileptics did 63% as well as the normals, but in the deferred reproduction only 41% as well.

Both the normals and the epileptics did decidedly better with F1 than with F3. The normals did only 40% as well in F3 as in F1, while the epileptics did only 59% as well. The reason that F1 was easier was probably due to the fact that there was no possibility of confusing the objects on F1 with the objects on any other cardboard. On the other hand, the objects on F3 could be easily confused with the objects on F1 and F2. Many subjects, in fact, could not recall whether certain objects had been shown on F3 or on the two earlier cardboards, and some subjects wrote down objects which belonged to F1 or F2.

The normal girls were able to remember the objects better than the normal boys, while the opposite was true for the epileptic girls. The normal boys did 81% as well as the normal girls in F1 and only 58% as well in F3, while the epileptic girls did only 33% as well as the epileptic boys in F1 and 54% as well in F3.

Based on the averages for F1 and F3, the ability to recall the objects increased with ascending age in six ages and decreased in six ages, when each age is compared with the next following age. The decreases occurred in ages 8, 12, and 16, in which, respectively, 72%, 62% and 75% were classed as average and dull, and also, strangely, in age 15 in which 75% were classified as bright.

6. CONCLUSIONS

1. The range of apprehension of the epileptics was about two-thirds as good as that of the normal pupils. It must be remembered, however, that our measurements are based on written and not on oral responses, and that the epileptics would probably have done relatively better had the responses been oral.

2. The range of observation, as determined by this test, was about the same among the normal boys and girls, but decidedly better among the epileptic boys than among the epileptic girls.

3. The extent of observation increases with ascending age among our normal pupils, under the conditions of this test. There is only one exception to this rule. The achievement of the oldest pupils is over two times as great as the achievement of the youngest pupils.

4. Large individual differences exist in the range of observation in this test, as shown by the extreme variations between the highest and lowest scores in each sitting, as follows:

	1	2	3	4	5
For the epileptics	0 to 55%	10% to 73%	10% to 52%	0 to 70%	10% to 55%
For the normals	0 to 80%	0 to 80%	0 to 80%	0 to 80%	20% to 90%

The individual differences in each age, based on the average score for all the sittings (1–5), are as follows for the normals:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	44.2	29.5	33.5	12.5	29.0	27.3	18.6	27.4	27.4	4.9	12.6

5. While the absolute monthly improvement was greater among the normal pupils than among the epileptics, the relative improvement (based on the index) was greater for the epileptics than for the normals. The normals gained more in only one index. Slightly over one-third of the pupils in both groups lost or failed to improve. The difficulty in scoring some of the inadequate responses may account for some of the losses.

6. The average monthly improvement in the range of observation under the conditions of the test was, in the main, slightly larger for the epileptic boys than for the epileptic girls, while the difference between the normal boys and girls was negligible.

7. There is no correlation between the extent of the monthly improvement in this test and the age of the normal children.

8. Both epileptic and normal pupils remember "things" better than letters, numbers or colors. This is undoubtedly partly due to the fact that children have greater native interest in things than they do in letters, numbers or mere patches of color, but it must also be emphasized that the names and letters were smaller and less conspicuous than most of the things, and therefore would naturally attract less attention.

9. The epileptics did relatively poorer in the deferred recall after a lapse of a month than in the immediate recall, compared with the normals. However, both the normals and the epileptics did very much poorer in the deferred recall, the normal pupils doing only about one-half as well and the epileptics about one-third as well as they did in the original test. The normal girls did relatively better than the normal boys, while the epileptic boys did relatively better than the epileptic girls, in the deferred recall.

10. Based on the age curve, this would seem to be a fairly valuable test of one of the aspects of intelligence. The test, however, is somewhat crude to administer and the scoring is not always easy. It could probably be improved by using only objects of a uniform black or white and accepting as satisfactory responses only the correct names of the objects and not merely different aspects of objects.

VIII. MEMORY OF LOGICAL AND ILLOGICAL ASSOCIATIONS

Reproduction of Sequents or Antecedents in Paired Associates: G1 to G5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

Each of the six stimulus sheets (of which only the first five were used), two of which are reproduced below, contains twenty pairs of words. Each of the blanks 1, 2, 3, 5 and 6 contains at least 16 logical associates, in which the sequent is associated with the antecedent because of meaning content, as in girl—doll, morning—sunrise, or tongue—taste. Each of these blanks also contains two pairs of illogical sequents, in which the antecedents do not naturally or readily suggest the sequents, although it would be possible, of course, to find some logical bond even between these apparently unrelated pairs of words. Two of these pairs consist of such senseless associates as the following: James—have, snow—that, within—he, wind—must; while the other two consist of a pair of number associates and a pair of letter associates, namely, 5—4, 11—10, 7—2, 14—6, 3—9, and 8—15; and E—D, I—H, K—F, A—L, B—N, and M—O. It will be observed that neither the numbers nor the letters in these associates follow in consecutive order. Aside from these associates, one pair of participles, and a few exceptions, all the pairs of words consist of nouns. The nouns are all familiar common nouns, with the exception of one pair of proper names (geographical) and one pair which contains the first name of a person as antecedent. With this arrangement it is possible to determine the difference in the ability to recall logical and illogical associates. It was thought that arranging the word lists systematically in the above manner would tend to equalize the difficulty of the different blanks, but this has not been proved to be the case.

1	Man—father	1	Woman—mother
2	John—not	2	Mary—is
3	Summer—flowers	3	Spring—showers
4	Santa Claus—Xmas	4	Monday—washing
5	Apples—pie	5	Soup—pepper
6	Muscle—bones	6	Hands—arms
7	Plow—field	7	Balloon—sky
8	Teeth—eating	8	Eyes—see
9	Bark—dog	9	Mew—cat
10	Eyebrows—eyes	10	Nails—toes

11	Cuffs—collars	11	Stocking—shoe
12	Rag—wash	12	Lamp—light
13	Barn—horses	13	Church—God
14	River—fish	14	Country—grass
15	Mice—rats	15	Hog—pie
16	Illinois—Chicago	16	New Jersey—Trenton
17	5—4	17	11—10
18	E—D	18	I—H
19	Running—walking	19	Diving—swimming
20	Dollar—than	20	Rain—and
	G1		G2

One blank was made up wholly of illogical sequents, namely G4. In comparing the results in the illogical set with the results in the logical sets, it must not be forgotten that all four of the latter contain four illogical pairs of associates.

Great care was taken to read the pairs of words in a loud, deliberate and distinct voice. The pauses were made longer between the different pairs of words than the pauses between the words of the same pair. By thus lengthening the pauses between the pairs, the subjects were enabled to hear the words of the same pair together, so that the proper associations would be formed—according to the principle of contiguity. The time required by the experimenter to read the forty words in paired intervals to the pupils averaged a little less than one minute for G1, G2, G3, and G5, and slightly over one minute for G4. The time required to test the pupils varied from two and a quarter to three minutes for the normals and from two and a half to five minutes for the epileptics. This includes the time required by the experimenter to read the 20 antecedents, the first words in the 20 pairs, and for the subjects to write the sequents.[1] The experimenter aimed to wait until all the children were through writing before proceeding to another pair of words. There is a strong temptation among some children (we noticed it particularly among the epileptics) to pronounce the sequent aloud after the experimenter has read the antecedent, in the recall series. The children must be especially cautioned not to speak the words, as this will ruin the test.

2. NATURE AND PURPOSE OF THE TEST

This is a species of association or memory test, in which we measure the ability of the subject to retain twenty pairs of supplied associates. We attempt to establish an association in the subject's mind between two ideas by repeating two words in close succession. We then test the strength of this

[1] In the deferred reproduction of G3 in April the process was the reverse; the experimenter read the 20 sequents (e.g., doll, have, sunrise, flag, etc.) and the subjects wrote the antecedents (girl, James, morning, July 4th).

association, or the ability of the subject to retain it, by pronouncing only one of the two words, while the subject must attempt to write the other word. In order to succeed in the test the subject must be able to apprehend the associations between the different pairs of words from the original reading, he must be able to retain the associations thus formed, and he must be able to write the appropriate word when called upon to do so. The greater the strength of the connection formed between the associates—or the stronger the suggesting associate—the better will be the recall. The strength of the connection will depend upon a number of factors: the degree of attention given, the vividness of the original impression, the degree of logical connection perceived between the ideas (resemblance, difference, cause and effect, etc.), the degree of suggestibility of the stimulus word, and, more or less, upon the individual's strength of memory. It is difficult to say off hand which is the most important of these factors. We are inclined to so consider the degree of attention given and the natural connection between the ideas. If this is true, we should expect this to be an excellent intelligence test. Our practical experience with the test has been very favorable. But for clinical purposes we have always used verbal instead of written responses. The writing of the responses, necessary in group tests, complicates the experiment and imposes a handicap on the pupils who have difficulty in writing and spelling. In order to minimize this handicap as far as possible, the pupils were told to spell as well as they could. Doubtless some pupils failed to react because they could not spell some of the words.

3. DIRECTIONS FOR GIVING THE TEST

Time: for reading the 20 pairs of words, approximately 60 seconds; for reading the first words in the pairs and for recalling and writing the second words in the pairs, from two to four minutes, depending on the age of the subjects. Distribute record sheets upside down to the pupils, with blank lines numbered vertically along the left margin from 1 to 20.

Instructions to Pupils: "I shall read you a list of 40 words which are arranged in 2's or in pairs. I want you to listen carefully and notice the words that go together, because after I have read all the words through I shall only read the *first* word of each pair, and then I want you to write down the second word, or the word that went with it. Let me show you what I mean by these pairs. Listen! *Stove—fire. Sleep—bed. Night—darkness. Stone—hard.* Now, what word went with *stove?* (Let the pupils answer). What word did I read with *sleep?* With *night?* With *stone?* Now you know what I mean. I shall now read the pairs of words. You will all have to listen very carefully, and keep very quiet. When you are asked to write the words you must be very careful not to speak them aloud. If you do not know how to spell the words, do the best you can. Now, listen!"

(Experimenter must pronounce the words very distinctly in a loud voice. The pauses *between* the pairs should be longer than the pauses *within* the pairs.) After the entire list has been read:

"Now turn your papers." "Man—("Write down the word that went with man opposite 1"). "John—("what word went with John? Write it opposite 2"). Etc. At the close have pupils turn papers as before.

Signature.

Scoring: 5% for each correct sequent supplied. 4%, if form of word is changed (e. g., singular for plural), or if word of similar sound is used. The following partial credits (4% unless otherwise stated) were given:

G1: then or van (for than); knox (for not; knot given full credit); bone (for bones); fields (for field); horse (for horses); eat (for eating); and washing (for wash).

G2: kiss, his, sis, or ist (for is); wash (for washing); arm (for arms; fly (for sky); sea (for see); shoes (for shoe); pile (for pie); swim (for swimming; and land (for and).

G3: has, had or halve (for have); soft (for salt); her or hearing (for hear); candle (for candy); eat (for eating).

G4: swiftly (for swift); looking (for look); there or ware (for where); eating (for eat); gray or prayer (for pray); "pinned" (for pin); cried or crying (for cry); upon (for on); bend (for bent); 16 (for 6); and love (for loving).

G5: best boy (for baseball); painting (for paint); hit (for hitting); this list is incomplete.

Special note may be made of the illogical or arbitrary pairs, No. 2, No. 17, No. 18, and No. 20. The illogical or arbitrary set, G4, should not be averaged with the five logical sets.

Deferred Reproduction of the Associated Sequents: The *first words* in the G1 set may be read during the next sitting by the experimenter (before G2 is presented), and the subjects asked to supply, as before, the associated sequents. This may also be tried for the illogical set, G4.

4. TABLES

TABLE 25

Immediate Recall of Sequents in Presented Paired Associates: G1—5.

NORMAL CHILDREN

No.	Ae	Sx.	1 %	2 %	$f\frac{2}{1}$	3 %	$f\frac{3}{2}$	4 %	$f\frac{4}{3}$	5 %	$f\frac{5}{4}$	1–2 %	3–5 %	$f\frac{3-5}{1-2}$	$f\frac{5}{1}$	1,2,3,5 %	Gain Ave. 1,2,3,5 %
2	7	B	26.5	29 0	.79	40.0	1.37	14.5	36	27.5	1.89	32 7	33.7	1.03	.75	33 2	—3.
2	7	G	43.5	40.0	.74	57.0	1.61	24.5	.45	62.0	2.53	40 0	59.5	1.57	1.55	52.7	7.4
4	7	Av	40.0	32.5	.76	48.5	1.53	19 5	42	44.7	2 32	36.3	46.6	1.39	1 28	43.0	1.8
8	8	B	52.3	50 7	.98	63.2	1.59	44.2	.60	59.7	1.65	52.2	61 5	1.54	1.16	56.5	2.5
3	8	G	36.0	42.0	1.25	51.6	1.24	30.0	.58	39.3	1.43	39.0	45 5	1.16	1 15	42.2	1.0
11	8	Av	47.9	48.3	1.06	59.5	1 49	37.9	.59	54 2	1.58	48 6	57.1	1.43	1.16	52.6	2.1
3	9	B	46.0	56 5	1.96	57 0	.96	36.6	64	72.3	2.06	52 6	64.6	1.29	2.08	58.7	8.7
4	9	G	31.7	48.3	1 25	57 0	1 30	28.2	.58	57.2	1.98	37.7	51.8	1 53	1.79	46.2	10 2
7	9	Av.	37 9	51.6	1.61	57.0	1.13	31.9	56	63.7	2.01	44.1	57.3	1.41	1.94	51.5	10.0
4	10	B	65 5	66.6	88	68.3	1.08	34 2	.51	88 1	3 27	65 0	80.8	1.25	1.36	72.6	9.1
3	10	G	63.0	61 6	1.00	59.6	.97	34 0	55	62.3	1 90	62.3	61 0	.95	1 00	61.6	— .2
7	10	Av.	64.4	64.1	.99	94.0	1.03	34 1	.53	77.1	2.68	63.8	72.3	1.12	1.21	67.9	4.6
3	11	B	67.6	69.3	1.03	61.0	89	26.3	.43	72 0	2.71	68.5	66.5	.96	1.05	67.4	1.4
8	11	G	71.5	67.1	.95	75.6	1.14	37 0	.49	82.1	2.54	69.3	77.1	1.14	1.21	74.1	4.4
11	11	Av.	70.4	67.7	.97	71.6	1 07	34.1	.47	79.1	2 59	69.0	73 9	1.09	1.16	72.3	3.2
5	12	B	64.4	72.0	1.17	69.8	.96	25.5	.34	71.6	2.87	68.2	70 7	1 02	1.09	69 5	2.5
3	12	G	67.6	68.0	1.05	66.6	1.00	35.6	.59	84 3	2.42	67 8	75 5	1.10	1 28	71.6	5.5
8	12	Av.	65.6	70.5	1.12	68 6	97	29.8	.45	76 3	2 70	68.0	72.5	1.05	1.16	70.2	3 7
4	13	B	72.7	70 0	.96	68.0	97	34.5	.50	83.2	2.69	70 7	75.7	1 06	1.15	73.8	4 2
2	13	G	71.0	72.5	1.03	79.5	1.14	49.0	61	91.5	1 85	71.7	85.5	1.19	1.28	78.6	6.8
6	13	Av	71 8	71.0	.99	71.8	1.03	39 3	.54	86 0	2.41	71.0	79.0	1.10	1 19	75 4	6 8
4	14	B	69.7	81 5	1.18	82.0	1.00	44.3	50	86.0	1 55	75 6	76 8	1.26	1.07	79 0	5.3
7	14	G	79.7	75 5	.94	78 4	1.08	36 5	.44	87.4	3 03	77.6	76 5	99	1.10	80.9	2.5
11	14	Av	76 0	77.7	1.03	80 0	1.05	38 9	.46	86.9	2.59	76.9	76.6	1 09	1.09	80.2	3.7
2	15	B	82.0	69.5	.85	99.0	1.16	59.0	68	97.5	1.65	75.7	89.2	1.17	1.19	84.2	6.2
2	15	G	79.5	76.5	.97	84.5	1.10	47.5	.56	90.0	1.95	78.0	87.2	1.11	1.13	82.6	3.5
4	15	Av.	80.0	73.0	.91	89.5	1 12	53 2	.72	94.0	1 80	76 9	88 2	1.14	1 16	83 4	4.7
1	16	B	93.0	89.0	.95	.....	.....	25.0	.28	80 0	3 20	91 0	52.5	.57	.86	87.3	—6.5
3	16	G	84 6	89.0	1 05	91.3	1.04	47 0	.51	84.6	1.79	86 1	88.0	1.01	.99	87 6	0.
4	16	Av.	87.0	89.0	1 02	91 3	1.04	41.5	.45	83.6	2.14	87.4	79.1	.90	.96	87.5	—1.3
1	17	B	80.0	90.0	1 12	64.0	.71	45 0	.70	99 0	2.20	85 0	81.5	96	1.23	83.2	6.3
2	17	G	79.5	85.0	.94	94 5	1.23	37.5	.40	90 0	2.50	83.5	92.2	1 10	1.15	87.0	4.2
3	17	Av.	79 5	87.5	1.03	84 0	1.05	40 0	50	93.0	2 40	87.3	88.6	1.05	1.17	85.7	5 0
Ave. B			62 8	64 6	1.09	66 3	1.13	35.4	.52	73.3	2 33	63.7	69 9	1.20	1.21	66 8	3.9
Ave. G			63.0	66 4	1.01	72 4	1 15	36 4	.51	76.1	2 29	64.6	74 3	1.11	1.18	69 5	4.0
Ave. B & G			62.9	65.5	1 05	69.4	1.14	35 9	.52	74.8	2.31	64 1	72.2	1.15	1.20	68.1	3.9

TABLE 26

Immediate Recall of Sequents in Presented Paired Associates: G1—5

EPILEPTICS

Su.	Ae.	Sx.	1/1	2/2	$f\frac{2}{1}$	3/3	$f\frac{3}{2}$	4/4	$f\frac{4}{3}$	5/5	$f\frac{5}{4}$	1-2/1-2	3-5/3-5	$f\frac{3-5}{1-2}$	$f\frac{5}{1}$	1,2 3,5 %	Gain Ave. 1,2 3,5 %
81	10	[illegible]	5.	.....	...	....	....	[illegible]	.00	30.0	....	5.0	15.0	3.00	6 00	17.5	25.
102	10	G	35 0	0.	00	0	....	0.	.....	25 0	.....	17.5	12.5	.71	71	15.0	-3.3
104	10	G	24.0	20.0	[illegible]	25.0	1.25	[illegible]	.00	39.0	.....	22.0	32.0	1.45	1.62	27.0	5
....	Av.	G	29 5	10.0	.41	12.5	1.25	0.	....	32.0	...	19 7	22 2	1 08	1 16	21 0	.8
99	11	G	53.0	24 0	.45	30.0	1.25	.	.....	35.0	..	38.5	32.5	.84	.66	35.5	-6.
79	12	[illegible]	20 0	20.0	1.00	25 0	1 25	10 0	.40	0.	00	20 0	12.5	.62	00	16.2	-6.6
84	12	[illegible]	45.0	45 0	1.00	45 0	1.00	10 0	22	53 0	5 30	45.0	49.0	1 08	1.17	47.0	2 6
91	12	B	37.0	40 0	1 08	65 0	1.62	20.0	.30	59.0	2.95	38.5	62 0	1 61	1.59	50.2	7 3
...	Av.	[illegible]	34.0	35.0	1.02	45 0	1 29	13.3	.30	37 3	2.75	34.5	41.1	1 10	92	37 8	1.1
[illegible]	12	G	0.	5 0	.	10 0	2 00	[illegible]	.00	0.	....	2 5	5	2.00	....	3.7	0.
93	13	[illegible]	0.	8.	.	4.	50	0.	00	5.	.....	4.0	4 5	1 12	.....	4.2	1.3
[illegible]	13	[illegible]	[illegible]	0.	.	0.	...	10.	....	0.	.00	0.	[illegible]	.	.....	0.	0
	Av.	[illegible]	....	4.	.	2.	.50	5.	....	2.5	...	2.	2.2	56	....	2.1	8.
97	13	G	33.	5.	.15	10	2.00	.	.	20.0	.	16 0	15.0	.93	.60	17.0	-4.3
77	14	[illegible]	70.	70.	1.00	70	1.00	24.	.34	69 0	2.87	70.0	69.5	.97	.98	69.7	- 3
[illegible]	14	[illegible]	25	[illegible]	.20	40.	8.00	0.	.00	55.	.....	15	47 5	3.16	2.20	31.2	10
...	Av.	B	47 5	37.5	.60	55.	4.50	12.	.17	62.	2.87	42 5	58.5	2 06	1.59	50.4	4.8
80	15	B	45.0	45.0	1.00	44.0	.97	0.	00	50	....	45.0	47.0	1 04	1.11	46.0	1.6
82	15	[illegible]	65.0	50.0	.76	75 0	1.50	19.	25	65 0	3.42	57 5	70.0	1 21	1.00	63.7	0.
[illegible]	15	[illegible]	30.0	35.0	1.16	30 0	.85	0.	.00	45 0	.	32 5	37 5	1 15	1.50	35.0	5.
...	Av.	B	46.6	43 3	97	49.6	1.10	6.3	08	53 3	3.42	45 0	51 5	1.13	1.20	48.2	2.2
103	15	G	5.0	0	00	0	.	0.	.....	0	...	2.5	0.	.00	.00	1.2	-1.6
[illegible]	16	[illegible]	60.0	73.0	1 21	49 0	.67	10.	.20	60.0	6.00	66 5	54 5	81	1 00	60 5	0.
88	16	[illegible]	45.0	72.0	1.60	75.0	1 04	10.0	.13	68.0	6 80	58 5	71 5	1.22	1.51	65.0	7 6
[illegible]	16	[illegible]	70.0	39.0	.55	65.0	1.66	15.0	.23	65 0	4.33	54 5	65.0	1.19	.92	59.7	-1 6
	Av	B	58.3	61 3	1.12	63.0	1.12	11.6	.18	64 3	5.71	57.5	63.6	1.07	1.14	61.7	2.
[illegible]	16	G	5.	0.	.00	0.	....	0	.	[illegible]	.	2 5	0.	.00	.00	1.2	-1.6
98	16	G	29.0	.	....	5.0	.17	5.	1.00	[illegible]	.00	29.0	2 5	08	00	11.3	-14 5
106	16	G	0.	10.	.....	10.	1 00	0.	.00	10.	.	5.0	10 0	2.00	...	7.5	3.3
[illegible]	16	G	39.0	40.	1.02	55 0	1.37	9.	.16	60.	6.66	39 5	57 5	1.45	1.53	48.5	7.
...	Av.	....	18.2	16.6	51	17 5	.83	3.5	.38	17.5	3.33	17 5	17 5	.88	.48	17.5	-.27
87	17	B	0	0.	.	4.	..	0.	.00	[illegible]	....	0.	2.	.....	.	1.0	0
[illegible]	17	[illegible]	5.	0.	.00	[illegible]	....	0.	.	0.	....	2 5	0.	00	.00	1.2	-1.6
	Av.	[illegible]	2.5	.	.	2.	.....	...	.....	.	....	1.2	1.	.....	....	1.1	-.8
95	17	G	0.	0.	....	0.	...	0.	..	0.	....	0.	0.	.	..	0.	0.
105	18	G	10.0	0.	00	0.	.....	0.	.	5.	....	5	2.5	50	.50	3.7	-1.6
107	21	G	0.	28.0	.	10.	.35	5.	50	10.	2 00	14	10	.71	.	12.	3.3
101	24	G	5.	15.	3.00	0.	.00	0.	.	0.	....	10	2.5	25	1.00	6.2	0.
Ave B			32.6	33 4	88	39.4	1.67	8.0	.14	39.0	3 51	33.0	39.1	1.28	1.46	36.2	2.2
Ave G			17.0	11.3	.68	11.0	1 04	1 5	.27	14 9	2 88	14.2	13.0	.76	.66	13.6	-.9
Ave B & A			25.3	19 6	[illegible]	26 4	1.21	5.2	.18	27.7	3.36	24 2	26.7	1.07	1.11	25.5	.7

TABLE 27

Percentage of Normal Pupils who Correctly Reproduced the Illogical Pairs of Words.

NORMAL CHILDREN

	John—not	5—4	E—D	Dollar—than	May—is	11 · 10	I—H	Rain—and	James—have	7—2	K—F	Snow—that	Esther—now	3—9	B—N	Wind—must
	No. 2	No. 17	No. 18	No.20	No. 2	No.17	No.18	No.20	No 2	No.17	No.18	No.20	No. 2	No.17	No.18	No.20
Ave B ..	.3	.7	.6	.02	.3	.8	4	06	.3	.6	.5	.2	.5	.6	.2	.1
Ave. G	.3	.5	.6	.02	.2	7	4	.05	.5	.6	.6	.3	.4	.8	.6	.1
Ave B & G	[illegible]	.6	[illegible]	.02	.3	.7	.4	.05	.4	.6	.6	.2	.5	7	.4	.1

TABLE 28

EPILEPTICS

	John—not No 2	5—4 No. 17	E—D No. 18	Dollar—than No.20	May—is No. 2	11—10 No 17	I—H No.18	Rain—and No.20	James—have No. 2	7—2 No.17	K—F No.18	Snow—that No.20	Esther—now No. 2	3—9 No.17	B—N No.18	Wind—must No.20
Ave. B...	1	.1	3	[illegible]	2	.1	.17	.0	.1	.1	.3	.0	.1	.2	.05	[illegible]
Ave. G	.07	07	1	.0	.0	07	[illegible]	.0	.0	.0	.07	.0	.1	[illegible]	.0	.0
Ave.B & G	.1	1	.2	.0	.1	.1	.1	.1	.06	.06	.2	.0	.1	.1	03	.0

5. RESULTS (See Tables 25 to 28)

IMMEDIATE REPRODUCTION

COMPARATIVE EFFICIENCY

The average efficiency of the normal group for all the sittings, except the fourth, which contains the illogical set, was 68.1% and for the epileptic group 25.5%. The normals recalled almost fourteen associates while the epileptics averaged only a little over five. The epileptics proved to be only 37% as efficient in this test as the normals. The average for the epileptics was only 60% as high as the average for the youngest normals, the seven-year-olds, and only 29% as high as the average for the oldest group of normals, the 17-year-olds. It is not possible to say whether this large difference was due solely to the inability of the epileptics to retain the associations. It is probable that it was at least partly due to their difficulty in writing the words. The average of the normal pupils for the set of illogical associates, G4, is only 52% as high as their average for the four sets of logical associates, while the epileptics' average for the illogical set is only 20% as high as their average for the four logical sets.

It must be remembered that each of the four logical sets contains four pairs of illogical associations. In Tables 27 and 28 we have tabulated the results separately for these pairs. We have, however, given only the general averages for all the boys and girls and the combined averages for both the boys and girls for sittings 1, 2, 3, and 5. The complete data are accessible for any one wishing to use them for each epileptic and for each chronological age for the normal pupils. The data for A-L and 14-G in G4 were incomplete for the epileptics and are therefore not given. The figures may be read as the average number of correct mentions per pupil for each combination, or as the per cent of pupils who correctly reproduced the combinations. The

average number of correct mentions per pupil were as follows (a perfect score would, of course, have been 1.):

	For John—not, Mary—is, James—have, and Esther—now.	For 5—4, 11—10, 7—2, and 3—7.	For E—D, I—H, K—F, and B—N.	For Dollar—than, Rain—and, Snow—that, and Wind—must.
Normals	.42	.71	.50	.12
Epileptics	.11	.11	.15	.00

The normals did somewhat better on the numbers (71%) which were given out of order (5—4, etc.) than they did on all the pairs in the four sittings (68.1%), but they did decidedly poorer on the three other illogical pairs. It is noteworthy that they did decidedly poorer on the pair of illogical word associates which came at the end of each series (dollar—than), than on the corresponding illogical pair which came at the beginning of the series (John—not). The same is true for the epileptics. The difference may be due to the factor of primacy. The epileptics did relatively much poorer than the normals, both in the set containing nothing but the illogical associates, and in the illogical pairs which occur in the four logical sets. It has been said that mental defectives can memorize illogical facts about as well as logically coherent facts, but this does not prove to be the case in this test with our epileptics.

The capacity of the normal boys in this test, based on the averages of sittings 1, 2, 3 and 5, amounted to 96% of the capacity of the normal girls. On the other hand, epileptic girls did only 37.5% as well as the epileptic boys. The comparative efficiency in the illogical set (G4) was, again, slightly higher for the normal girls than for the normal boys (who were 97% as efficient as the girls), while the epileptic girls were decidedly inferior to the epileptic boys. In fact, only three epileptic girls made any score at all. The comparative records of the boys and girls on the illogical pairs in G1, G2, G3 and G5 do not differ materially among the normal children, while the epileptic boys are decidedly superior to the epileptic girls, as shown in Tables 27 and 28.

Based on the sex averages for each sitting, given at the foot of the per cent columns, the normal girls did better in four sittings and poorer in one than the normal boys, the differences being small in most sittings, while the epileptic girls did decidedly poorer than the epileptic boys in all the sittings. Based on the sex averages for the different ages, for sittings 1, 2, 3, and 5 (third column from the right side), the normal girls excel in seven ages and the normal boys in four ages. Among the epileptics the boys excelled in four ages and the girls in only two, while no comparative data are available in the remaining ages.

The capacity to retain associations under the conditions of this test, improves from age to age among normal children. Based on the averages for the two sexes for sittings 1, 2, 3 and 5, there was an improvement in seven ages, and a loss in three, namely ages 9, 12 and 17. In age 9, 57% of the pupils were classed as dull and average as against 72% in age 8; in age 12, 62% were classed as dull and average as against 72% in age 11, while in age 17 all were classed as dull and average. It is evident that the exceptions are not satisfactorily explained by a preponderance of average and dull pupils in the ages concerned except in the case of age 17. The difference between the averages for the youngest pupils (who also made the lowest score) and the oldest pupils amounts to 42.7% (85.7%–43.0%). The highest average was made by the sixteen-year-olds. There is no consistent gain among the epileptics.

One epileptic did not score a single point in all the sittings, five failed entirely in four sittings, three in three sittings, three in two sittings, and seven in one sitting, five of the latter being in G4. One of the normal pupils (No. 5) failed completely in all five sittings, while two "dull" pupils in the second grade failed in one sitting (G4).

Excluding G4, the normals gained in all three of the successive sittings, while the epileptics gained in two of the three, based on the average scores at the bottom of the per cent columns. Both the epileptics and the normals made the highest score in the fifth sitting, while the normals made the lowest score (exclusive of G4) in the first sitting and the epileptics in the second.

COMPARATIVE IMPROVEMENT

The average monthly gain made by each subject during the five sittings (last column in the tables) amounted, in absolute units, to 2.6% for the normals and .5 for the epileptics. The improvement made by the epileptics amounted to only 19% of the improvement made by the normals. Based on G1, 2, 3 and 5, the normals improved 3.9% and the epileptics .7%, or only 18% as much as the normals. Based on the index of improvement, which expresses the improvement as a fractional part of the average scores, the normals gained more in three indices than the epileptics, and lost less in one, while the epileptics gained more in two sittings than the normals, as shown by the following per cents of improvement of the second sitting compared with the first, of the third compared with the second, etc.

	$\frac{2}{1}$	$\frac{3}{2}$	$\frac{4}{3}$	$\frac{5}{4}$	$\frac{5}{1}$	$\frac{3-5}{1-2}$
Normals	5%	14%	–48%	131%	20%	15%
Epileptics	–20%	21%	–82%	236%	11%	7%

The difference in favor of the normals amounts to 25% in the second index (gain in the second sitting over the first), 34% in the fourth, 9% in

the fifth sitting compared with the first, and 8% in the average of the third and fifth sittings compared with the average of the first and second. On the other hand, the epileptics gained 7% more in the third sitting compared with the second, and 105% more in the fifth sitting compared with the fourth.

According both to the indices of improvement and the scores in the per cent columns the normals lost only in the fourth sitting, while the epileptics lost in the second and fourth.

Based on the results in the column containing the average monthly gain for sittings 1, 2, 3 and 5, seven epileptics made no improvement, while eleven lost, or 60% of all the epileptics, while five normals made no improvement and three lost, which is 23% of all the normals.

The absolute monthly gain, based on the average gain for sittings 1, 2, 3 and 5, was about the same for the normal boys as for the normal girls (3.9% vs. 4.0%), but it was two and a third times greater for the epileptic boys than for the epileptic girls (a monthly gain of 2.2% vs. a loss of –.9%). Based on the average index of improvement at the foot of the columns, the normal boys gained more than the normal girls in $\frac{2}{1}$, $\frac{4}{3}$, $\frac{5}{4}$, $\frac{5}{1}$ and $\frac{3-5}{1-2}$, while the girls gained more than the boys in $\frac{3}{2}$. The epileptic boys likewise gained more than the epileptic girls in $\frac{2}{1}$ (smaller loss), $\frac{3}{2}$, $\frac{5}{4}$, $\frac{5}{1}$ and $\frac{3-5}{1-2}$, while the girls lost less than the boys in $\frac{4}{3}$. The gain in the fifth sitting over the first was 3% greater for the normal boys than for the normal girls (21% vs. 18%), and 80% more for the epileptic boys than for the epileptic girls (a gain of 46% vs. a loss of 34%). The gain based on the average of the third and the fifth sittings compared with the average of the first two ($f\,\frac{3-5}{1-2}$) was 9% more for the normal boys than for the normal girls (20% vs. 11%), and 52% more for the epileptic boys than for the epileptic girls (a gain of 28% vs. a loss of 24%).

Comparing the average monthly gains, based on 1, 2, 3 and 5 for each successive age, we find that the amount of the improvement increases among the normal pupils in six ascending ages and decreases in four. Based on the index ($f\,\frac{3-5}{1-2}$), there is an increase in four ascending ages and a decrease in six. Among the epileptics the gains or losses vary with the individual irrespective of chronological age.

DEFERRED REPRODUCTION

Retention of the Sequents or Antecedents After the Lapse of One Month
(The completed data are not available for tabulation).

In February, April, and May the pupils were asked to reproduce the associations contained in the tests given one month earlier. In G1 and G4 the experimenter read the antecedents and the subjects wrote the sequents, while in G3 the experimenter read the sequents and the subjects wrote the antecedents. The subjects had not been informed that these tests of retentiveness

would be given. The average score made by the normals in G1 and G3, respectively, was 28.4% and 16.2%. This is 45% and 23%, respectively, of the scores made by the normals in the immediate recall in the same tests one month earlier. The corresponding scores for the epileptics were 13.% and 2.5%, which is 51% and 9.4% of the original scores made one month earlier by the epileptics. The epileptics did not lose quite as much on their previous score in G1 as did the normals, but decidedly more in G3. It is noteworthy that both the normals and epileptics did much worse in G3 than in G1. We cannot conclude offhand that this was due to the reverse order of recall used in G3, because two sets of word associates had been presented before G3 was given, while no sets had been presented before G1 was given. It is apparent that this circumstance might explain the discrepancy. The difficulty of recall in G3 was increased because of the possibility of confusing the associates in G3 with the associates in G1 and G2.

The epileptics' efficiency in the original recall of G1 and G3 amounted to 40% and 38%, respectively, of the normals' efficiency in the immediate recall of the same tests. In the deferred recall the epileptics' efficiency in G1 and G3 amounted, respectively, to 45% and 15% of the normals' efficiency in the deferred recall of the same sets. Comparatively, the epileptics did somewhat better than the normals in the deferred recall of G1, but decidedly worse in G3. The efficiency of the epileptics, based on the average score of G1 and G3 (7.6%), amounted to 34% of the normals' average for the same sittings (22.1%). In the illogical set, G4, not a single epileptic was able to give a single associate, while the average score of the normals was only 1.04%, which is not quite 3% of the original score made by the normals in this set.

6. CONCLUSIONS

1. The immediate memory span as determined by this test, in which the subjects supply sequents in writing to a list of antecedents read by the experimenter, the antecedents and sequents having first been read together, was only a little over one-third as good for the epileptics as for the normal pupils, the normals reproducing a little more than two-thirds and the epileptics only one-fourth of the twenty pairs.

2. The memory of illogical associations was decidedly poorer than the memory of logical associations among both the normal and epileptic pupils, with the possible exception of the illogical numbers for the normal pupils. Contrary to the usual statement that mentally deficient subjects can memorize illogical subject matter about as well as logical subject matter, we find that the epileptics did relatively poorer in the illogical series than did the normal pupils, the former doing only one-fifth as well in the illogical list (G4) as in the logical lists of words, while the normals did over one-half as well.

3. The ability to reproduce verbal associations in this test was very slightly better for the normal girls than for the normal boys, but decidedly poorer for the epileptic girls than for the epileptic boys. This statement applies both to the logical and illogical associations, although the normal boys did somewhat better, comparatively, in the illogical series.

4. The ability to reproduce the missing sequents of words which were originally presented in pairs increases from age to age among normal children, the three exceptions to the rule probably being due to the fewness of the subjects in each age. The difference between the youngest and the oldest group is very considerable, the oldest pupils doing about twice as well as the youngest pupils.

5. The individual differences in this test are very considerable. The extreme variations in the different sittings are as follows:

	1	2	3	4	5
For the epileptics	0 to 70%	0 to 73%	0 to 75%	0 to 24%	0 to 69%
For the normals	0 to 95%	0 to 99%	0 to 100%	0 to 63%	0 to 100%

The individual differences in each age for the normals, based on the averages of the sittings 1, 2, 3 and 5, are as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	66.5	76.5	48.9	29.0	39.5	29.7	14.8	32.9	14.3	8.6	8.0

6. On the whole, the average monthly improvement was greater for the normal than for the epileptic pupils. The absolute gain was considerably greater for the normals; and, while the relative gain in the aggregate was smaller, the normals gained more consistently. The percentage of pupils who failed to improve was larger for the epileptics (60%) than for the normals (23%).

7. There was no significant sex difference in the amount of the average monthly improvement among the normal boys and girls, although the boys gained more than the girls in most sittings. The epileptic boys, on the other hand, clearly improved more than the epileptic girls.

8. There is no correlation between the amount of the monthly improvement in this test and the age of the normal children.

9. Both the normals and the epileptics did decidedly poorer in the deferred recall (after the lapse of one month) than in the immediate recall, both in the logical and in the illogical scores, but particularly in the illogical series (G4) in which the epileptics absolutely failed and in which the normal pupils almost failed, and also particularly in series G3, in which the antecedents were reproduced instead of the sequents. As we have already ex-

plained, the poorer showing in G3 may not be due to the reverse order of recall, but to the natural tendency, after a considerable lapse of time, of confusing the words in G3 with the words previously given in G1 and G2.

10. Our experience with this test, both in group and clinical work, indicates that it is one of the most valuable tests in the series. Our group curve for the different ages indicates that it can be successfully employed with normal children between 7 and 17, and probably beyond 17. While it proved too difficult for a number of epileptics, it would undoubtedly prove less difficult as an oral test. For clinical purposes oral responses are probably to be preferred.

IX. VISUAL IMAGINATION

The Ink-Blot Test: H2 to H5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

The test materials consisted of the four ink blots reproduced on p. 126, made from zinc block cuts from prints by the C. H. Stoelting Company. Ink-blot No. 6 was used in the second sitting, No. 20 in the third, No. 2 in the fourth, and No. 7 in the fifth sitting. These four blots were selected in the following manner: Seven adults were asked to pick out, independently, the six ink-blots from Whipple's complete set of twenty blots which they considered to be the "best" or the "most suggestive," or the "most fertile in imaginative possibilities." Blots Nos. 2, 6 and 20 were selected by five subjects and No. 7 by six subjects. The blot which was to be used in the fifth sitting received five votes, while the remaining blot (which we had provisionally determined to use in the first sitting) received only two votes, and was therefore rejected. We do not feel that these blots are equally suggestible or equally rich in imaginative detail and we have accordingly made no attempt to compute indices of improvement from the results for the different blots.

2. NATURE AND PURPOSE OF THE TEST

The ink-blot test was suggested in 1895 by Binet and Henri and has since been employed by G. Dearborn, E. Kirkpatrick, Stella E. Sharp and W. H. Pyle, as a test of the fertility of visual imagination, or the degree of suggestibility or imaginativeness. As here administered the test should be classed as a test of active, productive imaginaion, for the subject is asked not merely to look passively at the blots and permit his fancy spontaneously to suggest objects or pictures in them, but he is asked diligently to search out as many resemblances or suggestions as he can find, to construct new forms and to read new interpretations into the patterns. It is, therefore, less a test of reverie than a test of dissociation, abstraction, inventiveness, recombination or reconstruction (of images). In a word, it is a test—although perhaps a rather crude one—of an important aspect of intelligence. It should be emphasized that in our use of the test the responses consisted of written words. Had the subjects been asked to *draw* pictures or reconstructions of the blots in accordance with the ideas which they suggested, the results would probably have been different.

6.

20.

2.

3. DIRECTIONS FOR GIVING THE TEST

Time: for exposing the blots and writing the answers, 90 seconds (one minute and 30 seconds).

Distribute the ink-blot cards upside down, requiring the subjects to sit with folded hands, so that they will not turn the cards over before being instructed to do so. Also distribute plain sheets of paper, appropriately numbered (H2, etc.), for the records.

Instructions to the Pupils: "On the other side of the small cards you will find a large ink-blot. I want you to look at it, when I tell you to do so, write down on the blank sheet of paper everything that you think you can see in the blot. You should try to imagine that you can see different things or pictures in the blot, just as we often picture things in clouds, or fancy that we see things in the fireplace, although we know that they are not really there. Turn the card around so that you look at it in many positions, for I want you to write just as many things as you possibly can. But do not write on the card with the ink-blot."

"Now, ready! Turn the cards over!"

"Now, stop. Turn your papers. Sign your names."

Scoring: record the number of different "imaginations" or different things written. Our records in this test are purely quantitative. We have merely recorded the number of things suggested by the blots. We have not attempted to evaluate the answers. Needless to say, some of the "imaginations" were qualitatively better than others. Many of the imaginations, particularly among the younger pupils, seemed to be quite bootless and far-fetched, and would have been given a low score in a qualitative rating. We have the original records only in H5, which we may analyze qualitatively or otherwise in future.

4. TABLES

TABLE 29

Ink-blot Test of Visual Imagination: H2–5.

NORMAL CHILDREN

No.	Age	Sex	2 No.	3 No.	4 No.	5 No.	2-5 Average
2	7	Boy	.5	1.5	1.0	4.0	1.7
2	7	Girl	6.0	7.0	7.0	6.0	6.3
4	7	Ave.	2.3	4.2	4.2	5.0	4.0
7	8	Boy	4 1	4.0	4.2	4.1	4.0
3	8	Girl	5.3	5.0	5.0	2.6	4.5
10	8	Ave.	4.2	4 6	4.5	3.7	4.1
3	9	Boy	4.5	0.	2.6	3.0	2.2
4	9	Girl	8.3	4.3	3.2	2.5	4.3
7	9	Ave.	6.8	2.2	3.0	2.7	3.4
4	10	Boy	5.3	5.0	5 0	5.0	4.8
3	10	Girl	5.6	5.3	3.6	4.0	4.6
7	10	Ave.	5.5	5 2	4.4	4.6	4 7
3	11	Boy	2.0	4.0	1.6	2 0	2.4
8	11	Girl	5.5	5.2	4.0	4 5	4 8
11	11	Ave	4.5	4.9	3.3	3.2	4.3
5	12	Boy	5.2	6.4	8.7	5 4	6.0
3	12	Girl	7.3	6.3	7.6	6.0	6.8
8	12	Ave.	6.0	6 4	8.2	5 6	6.2
4	13	Boy	6 3	4 2	3.2	4.2	4.2
2	13	Girl	4.0	4.0	3.0	3.5	3.6
6	13	Ave.	5 4	4.1	3.1	4 0	4 0
4	14	Boy	6.0	6.2	5.0	7.3	6.4
7	14	Girl	5.1	5.8	3.0	5.0	4.7
11	14	Ave.	5.5	6.0	3.6	5.7	5.4
2	15	Boy	3.0	5 0	3 0	3.0	3.2
2	15	Girl	6.0	10.0	5.0	7.5	7.1
4	15	Ave.	4.5	8.3	4.0	5.3	5.1
1	16	Boy	3.0	....	4.0	3.0	3.3
3	16	Girl	8 5	5.6	4.6	7.3	6.2
4	16	Ave.	6.6	5.6	4.5	5.3	4.0
1	17	Boy	4.0	4.0	4.0	1.0	3.2
2	17	Girl	9.0	7.0	4.0	3.0	5.1
3	17	Ave.	6 5	6.0	4.0	2.3	4.5
Ave. Boys			4.3	4.2	4.1	4.2	4.2
Ave. Girls			6.0	5.7	4.2	4.6	5.1
Ave. Boys and Girls			5.2	5.0	4 2	4 4	4.7

TABLE 30

Ink-blot Test of Visual Imagination: H2—5

EPILEPTICS

Su.	Age	Sex	2 No.	3 No.	4 No.	5 No.	2-5 Ave.
81	10	Boy	....	.....	1.	4.	2.5
102	10	Girl	....	1.	2.	1.	1.3
104	10	Girl	6.	1.	4.	2.	3.2
.....	.....	Ave.	6.	1.	3.	1.5	2.4
99	11	Girl	9.	6.	.....	7.	7.3
79	12	Boy	0.	0.	2.	0.	.5
84	12	Boy	5.	5.	2.	4	4.
91	12	Boy	4.	4.	4	4	4.
.....	.....	Ave.	3.	3.	2.6	2.6	2.8
108	12	Girl	2.	2.	1.	2.	1.7
93	13	Boy	2.	1.	4.	2.	2.2
86	13	Boy	3.	4.	2.	0.	2.2
.....	.....	Ave.	2.5	2.5	3.	1.	2.2
97	13	Girl	3	3.	.....	2.	2.6
77	14	Boy	4.	2.	3.	6.	3 7
89	14	Boy	3.	1.	1.	1.	1.5
.....	.....	Ave.	3.5	1.5	2	3 5	2 6
80	15	Boy	2.	2.	1	2.	1.7
82	15	Boy	2.	3	1.	2.	2.
83	15	Boy	0.	0	0.	0.	0.
.....		Ave.	1.3	1.6	6	1.3	1 2
103	15	Girl	0.	3.	1.	0.	1.
78	16	Boy	1.	1.	1.	2.	1.2
88	16	Boy	3.	6	6.	3.	4.5
85	16	Boy	4.	4.	1.	5.	3 5
.....	.....	Ave.	2.6	3.6	2.6	3.3	2.3
96	16	Girl	1.	1.	0.	0.	.5
98	16	Girl	.....	1.	1.	2.	1.3
106	16	Girl	0.	1.	2.	3.	1.5
100	16	Girl	4.	5.	10.	6	6.2
.....	.....	Ave.	1.6	2	3 2	2 7	2.4
87	17	Boy	2.	4	9.	8.	5.7
90	17	Boy	0.	1.	0.	0	.2
.....	.....	Ave.	1.	2 5	4.5	4.	3.
95	17	Girl	0.	0.	0.	0.	0.
105	18	Girl	3.	2.	0.	3.	2.
107	21	Girl	2.	2.	2.	3.	2.2
101	24	Girl	1.	5.	2.	1.	2.2
Ave. Boys			2 3	2.5	2.3	2 6	2.4
Ave. Girls			2.5	2.5	2.0	2.2	2.3
Ave. Boys and Girls			2.4	2.5	2.2	2.5	2.4

5. RESULTS (See Tables 29 and 30)

The average number of suggestions or imaginations, based on the averages for all four sittings given at the bottom of the last column in the tables, was 4.7 for the normals and 2.4 for the epileptics. In other words, the epileptics got only 51% as many suggestions out of these blots as did the normal children. The general average for the epileptics was less than the average

in any age for the normal children, while the general average for the epileptics for each blot was only about one-half as high as the average for the corresponding blot for the normal children. The epileptics got 60% as many suggestions as the youngest normal group, and 53% as many as the oldest group, based on the averages of sittings 2 to 5. One epileptic failed entirely in all the sittings, three in three sittings, one in two, and three in one sitting, which is 26% of all the epileptics. Only two normal children failed in as many as two sittings, while five failed in one sitting, or 9% of all the normals. We cannot infer offhand that this large difference was due solely to the infertility of the "imagination" of the epileptics. It may at least have been partly due to the inability of the epileptics to write what they imagined, because of the difficulty of writing or of spelling the words.

The number of imaginations given by the normal boys was 82% as high as the number given by the normal girls, while the number of imaginations given by the epileptic girls was 96% as high as the number given by the epileptic boys. The normal girls got more suggestions from every blot than the normal boys, based on the averages at the bottom of the columns, the greatest difference amounting to 1.7 imaginations (H2), while the smallest difference amounted to only .1 (H4). The epileptic boys got more suggestions from two blots and fewer suggestions from one blot than the epileptic girls, while the result is the same for one blot. But the difference among the epileptics does not exceed .4 for any blot. Based on the sex averages for the different ages for all four blots (last column), the girls excelled in eight ages and the boys in three ages among the normal pupils, while among the epileptics the girls excelled in two ages and the boys in four.

The most suggestive ink blot in the case of the normal pupils was No. 6, shown in the second sitting, and in the case of the epileptics Nos. 20 and 7, which proved to be equally suggestive, shown in the third and fifth sittings. The least suggestive blot for the normals and for the epileptics was No. 2, shown in the fourth sitting. The normals made the highest score in the second and third sittings and the lowest in the fourth and fifth. We may assume that the loss during the last two months represents a difference in the degree of suggestibility of the blots rather than a decline in imaginative fertility. At the same time, it is possible that the normal pupils grew more critical as the tests proceeded, and therefore wrote less in sittings 4 and 5. The greatest difference between the averages of the different ink-blots amounts to one suggestion for the normals and only .3% of a suggestion for the epileptics.

Based on the age averages for the normal children for all the sittings (last column), there was an increase in the number of suggestions in five ages and a decrease in five ages. The difference between the averages for the lowest and for the highest age amounts to only .5 of a suggestion. The high-

est score was made by the twelve-year-olds and the lowest by the nine-year-olds. Had the records been scored qualitatively the results might have been different.

6. CONCLUSIONS

1. The normal pupils proved to be about twice as suggestible or imaginative in the ink-blot test as the epileptics. It is possible that the difference would not have been so large had verbal responses been used instead of written responses.

2. The normal girls ranked slightly higher than the normal boys in degree of suggestibility. The epileptic boys were more suggestible than the epileptic girls, but the difference was insignificant.

3. The degree of imaginative suggestibility was probably not the same for the different ink-blots.

4. We find no significant age difference in imaginativeness or suggestibility as determined by this test. Kirkpatrick and Pyle in experiments on ink-blots found a tendency of the imaginativeness to decline with increasing age. Such a tendency in this test would be explicable on the assumption that children grow more critical of their perceptions as they grow older. On the other hand, children acquire a richer fund of experience as they grow older and therefore ought to be able to "see" more in the blots. The "nascent stages" for imagination differ, of course, with the type of imagination concerned. In an earlier experiment in suggesting perspectives, the most suggestible age between 9 and 16 seemed to come at 12 and the least at 16.[1]

5. The extent of the individual differences in this test is indicated by the following figures, showing the lowest and the highest number of "imaginations" given for each ink-blot (sittings 2 to 5):

	2	3	4	5
For the epileptics	0 to 9	0 to 6	0 to 10	0 to 8
For the normals	0 to 14	0 to 12	0 to 15	0 to 14

The individual differences in each age for the normals, based on the averages for sittings 2 to 5, are as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	6.5	5.	3.7	7.	5.	12.2	5.5	8.4	5.8	3.7	2.8

6. This does not seem to be a very valuable test for measuring the (imaginative) capacity of children of various ages nor of measuring extent of improvement with time: first, because the performance in the test does not correlate significantly with age; second, because the different ink-blots are of unequal degree of suggestibility; and, third, because the trait concerned may be more specific, in spite of what we have said on page 125, than most of the other traits which we have here measured. We need to determine the degree of correlation between "imagination" and general intelligence.

[1] J. E. Wallace Wallin. Optical Illusions of Reversible Perspective, 1905, 213—232.

X. WORD CONSTRUCTION

Building Words from Six Supplied Letters: I1 to I5.

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

Six letters in 10 point type were printed at the top of the test blanks, which measured 4½ x 7½ inches (see below; I6 was not used in this experiment). In attempting to determine the best combination of letters to use for the different blanks we made preliminary tests with twelve different sets of six letters (three vowels and three consonants in each set) on three colleagues (physicians). The experimenter also tested himself. These preliminary tests indicated that there was considerable difference in the difficulty of the different sets, from the standpoint of the number of words which were constructed in the same amount of time. Four sets seemed to be almost in a class by themselves, namely, a e o b m t; e a i r l p (both of these from Whipple), o e a s d n (from Terman), and i a e h t f, for there were more words written with these than with any other combination of letters. And yet we cannot conclude that these four are of equal difficulty, for more words were written with the first two sets of letters (some doing better in the first and some in the second), than with the last two sets. It will be observed from the key supplied in the third section that more words can be constructed from the combination e a i r l p than for a e o b m t, and more words were actually made by our normal subjects with the former set of letters. Curiously, no one regarded e a i r l p as the easiest combination. Two said that the easiest combination was a e o b m t. Two did not know which was the easiest. One said the combination i a e h t f was the hardest, and two the combination o e a s d n. These judgments, however, were not always borne out by the number of words which the different subjects constructed. We did not deem it advisable to include any of the other sets which we investigated, and have therefore been obliged to use two combinations twice, as shown below:

a e o b m t
I1

a e o b m t
I2

e a i r l p
I3

e a i r l p
I4

o e a s d n
I5

i a e h t f
I6

We must have available a sufficient number of sets of standardized letter combinations before we can hope reliably to measure progress in word-building capacity.

2. NATURE AND PURPOSE OF THE TEST

Success in this test depends upon a number of factors: extent of vocabulary, ability to spell (and write) correctly, fertility of invention or resourcefulness in combining the letters in a great number of ways, and ability to keep the attention concentrated on the problem. Other things equal, the person who has the largest vocabulary and who can spell correctly will score highest in the test, because he will recognize more genuine words, and will thus be able to reject imaginary and misspelled words. Some of our subjects wrote a considerable number of imaginary words. Of course, for the time spent in writing these words they received no credit. On the other hand, when no demerits are imposed for the wrong words written a person of limited vocabulary who is very fertile in combining the letters in a great variety of ways might overcome the advantage possessed by the one who has a rich vocabulary, for some of the numerous words written will of necessity be correct. Some words will be correct as a mere matter of chance. It is evident that the person who possesses a good vocabulary and, at the same time, is very resourceful in associating the letters in varied ways, and who is able to keep his attention highly concentrated will excel in the test. Besides testing resourcefulness, ingenuity, and ability to hold attention on a task, we also test the individual's "combining" activity in this test—that is, the ability of the individual to combine isolated parts into a totality. According to Ebbinghaus, the combining of elements into a whole is of the very essence of intelligence. From these several points of view we seem justified in classing the word-construction test as a test of intelligence.

3. DIRECTIONS FOR GIVING THE TEST

Time: Exactly three minutes. Place the blanks with the letters upside down on the desks, with instructions to the pupils not to turn them until they are requested to do so.

Instructions to Pupils: "On the other side of the blanks you will find at the top six letters. I want you to make as many words as you can out of these six letters. Put them together into as many different words as possible. You must not use more than six letters in any word; you must not use any

other letters than those given; and you must not use the same letter twice in the same word. Let me show you what I mean with these letters: u i a d c n (Place on board). From these letters we can spell: *cud, cad, can, Dan, Dina, ai, aid.* But not: *nina,* or *nun,* or *naiad.*" (It is well to emphasize that the words coined must be recognized words and not mere inventions.)

"Now, ready!" "Turn!"

"Now, stop! Turn! Sign your names."

Scoring: Record the number of words correctly constructed. The number of words wrongly constructed may be noted, and a tabulation of the words may also be made. The imposition of a penalty for wrong words would probably discourage guess work.

The following key indicates the words which may be constructed from three of the combinations. We have taken pains to make the lists unusually complete for the first two sets of letters. The list for the latter set is incomplete. We have included obsolete and dialectic words, abbreviations and words spelled according to the reformed spelling, for the first two sets of letters. These unusual words are given in italics. Lists without the unusual words have been provided by Whipple for a e o b m t and e a i r l p.

A E O B M T

a, ab, Abe, abet, *abt,* am, ambo, *amt,* at, ate, *atmo,* atom, *ba,* bam, bat, bate, be, beam, beat, bema, bet, beta, bo, boa, boat, *bom, boma,* bot, bote, ea, *eam,* eat, eb, em, eta, ma, mao, Mae, Mab, mat, mate, me, meat, met, meta, *mo,* moa, Moab, moat, mob, *moe,* mot, mote, o, oat, *ob, obe, obt,* om, *ta, tab, tabe, tam,* tambo, tame, tea, team, *tema,* to, toe, Tom, tome.

E A I R L P

a, ai, *aiel,* ail, *aile,* air, *aire,* al, ale, alp, ape, *apl,* April, ar, are, Ariel, aril, ea, ear, earl, *el,* ela, Eli, epi, *er,* era, eria, I, *il, ile,* Ira, ire, irpe, la, lair, lap, *lare, le,* lea, leap, Lear, *lep,* lepra, lerp, *li,* liar, lie, lier, lip, lira, *lire, lirp,* pa, *paie,* pail, pair, pal, pale, paler, pali, par, *pareil,* parel, *parl,* pea, peal, pear, pearl, *pel, pela,* per, peril, pi, pia, pie, *piel,* pier, pil, pile, *pilar, piler, pire,* plea, *plie,* plier, *prial, prie,* Ra, Rae, rail, rale, rap, rape, re, Rea, real, reap, rei, rep, rial, *ril,* rile, rip, ripe.

O E A S D N

a, *ad,* aden, *ae,* an, and, as, e, *ean, ed,* end, Eos, *da,* Dan, dane, de, *dea,* dean, *deas,* den, do, doe, does, don, done, dose, *na, nae, ne, nea,* Ned, no, nod, nose, o, *od,* ode, on, one, one's, os, sad, *sade, sae, san,* sand, sane, sea, *sead, sed,* sedan, *sen,* send, so, sod, soda, *soe,* son.

4. TABLES

TABLE 31

Building Words from Six Supplied Letters: I1—5

Sittings 1 and 2: a e o b m t

Sittings 3 and 4: e a i r l p

Sitting 5: o e a s d n

NORMAL CHILDREN

No.	Ae.	Sx.	1 No.	2 No.	$f\frac{2}{1}$	3 No.	4 No.	$f\frac{4}{3}$	5 No.	1-2 Av. No.	3-4 Av. No.	$f\frac{3-4}{1-2}$	Ave. 1-5
2	7	B	2 5	2 0	.80	1 5	2 0	1.33	2.0	2.2	1.7	.77	2.0
2	7	G	3 0	2 0	2 00	4.	7.0	1.75	3.5	3.2	5 5	2.50	4.1
4	7	Av.	2.7	2 0	1.40	2.7	4.5	1.61	2 7	2.7	3 6	1.92	3 0
7	8	B	4 1	4.1	1 19	5.1	5.1	.99	4.5	4.1	4.8	1.21	4.5
3	8	G	4 0	5.3	1 41	2 6	2 0	1.05	3.6	4.8	2 3	.52	3.6
10	8	Av.	4.4	4 7	1 25	4.4	4.2	1.01	4.2	4.3	4 5	1.02	4.2
3	9	B	1	3 5	3.50	3 6	3.3	1.22	2.6	2.	3.5	1.75	2.7
4	9	G	4 7	4 0	1 40	7 0	4.7	.75	5.7	4.3	6.1	1 70	5.1
7	9	Av.	3.1	3 8	2.24	5 3	4.1	.99	4.4	3 3	4.8	1.73	3.6
4	10	B	8.5	9.5	1.32	11 3	11.5	1 20	9.7	9.4	10 6	1.22	10 4
3	10	G	6.6	6.0	.84	5 33	7.3	1.43	7 7	6.3	7.6	1.42	6.6
7	10	Av.	7.7	7.8	1 06	8 3	8.3	1.32	8.8	8.1	9.3	1.31	8.7
3	11	B	9 6	9.0	.86	9.0	13.0	1.75	9.6	9.3	11.0	1 28	10.6
8	11	G	8 2	11.3	1.57	8 8	9 8	1.13	8.0	9.8	9.3	.96	9.6
11	11	Av.	8 6	10 6	1 38	8.9	10 7	1.32	8 5	9.6	9.6	1.06	9.8
5	12	B	8 2	10 0	1.23	9 4	12 7	1 21	8.8	9.4	10.3	1.10	9 5
5	12	G	7.6	12.3	1.72	11.6	12.0	1.19	9.3	10.0	11.6	1.07	10 6
8	12	Av.	8.2	10 2	1 43	10.2	12.4	1.20	9.0	9 6	10 6	1.09	9 9
4	13	B	9 5	16.6	1 55	13 2	15.5	1.17	14 7	11.6	14 3	1.43	13.4
2	13	G	10.0	9 0	.92	10.5	12.0	1.30	12.0	9.5	11 2	1.12	10.7
6	13	Av.	9.7	13.6	1 39	12.3	14.3	1.21	13 8	10 9	13.3	1.33	12.6
4	14	B	9.0	12.5	1 27	11.0	12.6	1.28	8.0	10.0	11 7	1.16	10.3
7	14	G	8.4	15.1	1 91	13.2	14.3	1.16	13 1	11.8	13.5	1.15	12.4
11	14	Av.	8 6	14.4	1.72	12.2	13 8	1.19	11.6	11.1	12 8	1.15	11.6
2	15	B	16.0	17.0	1.04	19 0	19 0	1.10	12.5	16.5	18.5	1.13	16.0
2	15	G	16.0	14.0	.86	18.0	16 0	.89	7.0	15.0	14.5	.96	14.2
4	15	Av.	16 0	15.5	98	18.3	17.5	.96	9 7	15 7	16.3	1.05	15 1
1	16	B	15 0	16.0	1.06		14 0	....	13.0	15 5	14.0	.90	14.5
3	16	G	7.6	12 5	1.39	10 3	10 0	.95	14 0	9.0	10.1	1.33	10.8
4	16	Av.	9.5	13 6	1.28	10 3	11.0	95	13.7	10.6	11.1	1.22	11.7
1	17	B	13 0	18 0	1.38	18.0	21 0	1.16	15.0	15.5	19 5	1.25	17.0
2	17	G	16.0	16 0	1.06	14 5	17.0	1.24	11.0	16.2	15.7	1.07	14.9
3	17	Av.	15.0	17.0	1.22	15 6	18.3	1.23	11.3	16.0	17.0	1.13	15.6
Ave.	S	. .	7.8	9 2	1.35	8.7	10.5	1.21	8.2	8.5	9.6	1.24	8 8
Ave.	S	. .	8 0	10.6	1 47	9.5	10.1	1 15	9 0	9.2	9.8	1.19	9.4
Ave	S & S		7.9	9.9	1 41	9 1	10.3	1.18	8.6	8.9	9 7	1.21	9 1

TABLE 32

Building Words from Six Supplied Letters: 11—5

Sittings 1 and 2: a e o b m t

Sittings 3 and 4: e a i r l p

Sitting 5: o e a s d n

EPILEPTICS

Su.	Ae.	Sx.	1 No.	2 No.	$f\frac{2}{1}$	3 No.	4 No.	$f\frac{4}{3}$	5 No.	1-2 Av. No.	3-4 Av. No.	$f\frac{3-4}{1-2}$	Ave. 1-5
81	10	Boy	3.	.....	.....	.	3.		2	3.	3.	1.00	2.6
102	10	Girl	11.	...	.	6.	6.	1.00	11.	11.	6.	.55	8.5
104	10	Girl	7.	6.	.85	2.	4.	2.00	5.	6.5	3.	.46	4.8
.....	....	Av.	9.	6.	.85	4.	5.	1.50	8.	8.	4.5	.50	6.4
99	11	Girl	3.	3	2.00	6.		.....	6.	4.5	6.	1.33	5.2
79	12	Boy	1.	1.	1.00	0	1.	.	1.	1.	.5	.50	.8
84	12	Boy	6.	6.	1.00	3.	6.	1.00	4.	6.	3	1.00	5.6
91	12	Boy	0.	0		0.	1.	....	0.	0.	.5	.....	.2
.....	..	Av.	2.3	2.3	1.00	2	2.6	1.00	1.6	2.3	2.3	.75	2.2
108	12	Girl	0.	4	.....	0.	0	. . .	0.	2.	0	.0	.8
93	13	Boy	2.	1.	.50	0.	0.	.... ..	2.	1 5	0.	.0	1.
86	13	Boy	1.	0	.0	2.	1.	.50	0.	.5	1.5	3.	.8
.....	...	Av.	1.5	.5	.25	1.	5	.50	1	1.	.7	1.5	.9
97	13	Girl	4.	4	1.00	1.	....	.....	5.	4.	1.	.25	3 7
77	14	Boy	5.	4.	.80	6.	3.	1.33	6.	4.5	7.	1.55	5 8
89	14	Boy	4.	0.	0	4.	4.	1.00	7.	2	4	2.00	3 8
.....	....	Av.	4.5	2.	.40	5.	6.	1.16	6 5	3.2	5.5	1.77	4.8
80	15	Boy	4.	5.	1.25	2.	2.	1.00	5.	4.5	2.	.44	3.6
82	15	Boy	1.	9.	9.00	7.	9.	1.28	5.	5.	8.	1.60	5.2
83	15	Boy	2.	2	1.00	2.	1.	.50	2.	2.	1.5	.75	1.8
.....	...	Av.	2.3	5 3	3 75	3.6	4.	.92	4.	3.8	3 8	.93	3.8
103	15	Girl	2.	3.	1 50	1.	2	2.00	0.	2.5	1.5	.60	1.6
78	16	Boy	1.	2.	2.00	0.	1.	.....	0	1 5	.5	.33	.8
88	16	Boy	1.	2.	2.00	4.	2.	.50	3.	1.5	3.	2.00	1.8
85	16	Boy	6.	7.	1.16	0.	8.	....	6.	6.5	4.	.61	5.4
.....		Av.	2.6	3.6	1 72	1.3	3.6	.50	3.	3 1	2.5	.98	2.8
96	16	Girl	1	0.	.0	1	0	.0	2.	.5	.5	1.00	.8
98	16	Girl	4	....	.....	0.	2.	.....	5.	4.	1.	.25	2.7
106	16	Girl	3.	3.	1.00	4	4.	1.00	0.	3.	4	1.33	2.8
100	16	Girl	1	5.	5 00	1.	0	.0	4	3.	.5	.16	2.2
...		Av	2.2	2.6	3 00	1.5	1.5	33	2.7	2.4	1.5	.68	1.9
87	17	Boy	0.	4		0.	4.	.	1.	2.	2.	1 00	1.8
90	17	Boy	1.	1	1.00	5	6.	1.00	5.	1.	6.	6.00	3.8
.....	.	Av.	.5	2.5	1.00	3.	5.	1 00	3.	1 5	4.	3.50	2.8
95	17	Girl	1.	0.	.0	0.	2.	.. ..	3.	.5	1.	2.00	1.2
105	18	Girl	2.	3	1.50	2	0.	.....	2.	2 5	1.	.40	1.8
107	21	Girl	2.	6.	3.00	0.	0.	. .	0.	4.	0.	.00	1.6
101	24	Girl	0.	0.	....	1.	0.	.....	1.	0.	.5	.. ..	.4
Average Boy...			2 3	2 9	1.58	2 6	3.5	.91	3.0	2.6	3.1	1.45	2.9
Average Girl			2.9	3 3	1 67	1.7	1 6	.75	3.2	3.1	2.0	.63	2.5
Average B & G			2.6	3.1	1.62	2.2	2.7	.83	3 1	2.8	2 6	1.07	2.7

5. RESULTS (See Tables 31 and 32)

COMPARATIVE EFFICIENCY

The average number of words written in the four sittings was 9.1 for the normal pupils and 2.7 for the epileptics. The epileptics constructed 29% as many words as the normal pupils. The average for the epileptics was a little less than the average for the youngest group of normal children, and only 17.3% as large as the average for the oldest group. The epileptics did relatively poorer on the e a i r l p combination than on the a e o b m t combination. With the former set of letters they did only 24.7%

as well as the normals, while with the latter they did 26.8% as well. Their best record, relatively, was made with the combination o e a s d n, with which they did 36% as well as the normals. The highest score by the normals was made with the combination e a i r l p, and the lowest score with o e a s d n (comparing the averages of sittings 1 and 2, and 3 and 4 with the average of sitting 5). The greatest difference between the averages in the five sittings was 2.4 words for the normals and .9 of a word for the epileptics. Both the normals and the epileptics made a lower score during the first trial than during the second trial with a e o b m t and e a i r l p. In the former set the normals gained two words in the second trial and the epileptics .5 of a word, while in the latter set the normals gained 1.2 words and the epileptics .5 of a word.

The normal boys built 93% as many words as the normal girls, and the epileptic girls 86% as many as the epileptic boys, based on the averages of all five sittings. The normal girls made more words than the normal boys in every sitting except one, the greatest difference amounting to 1.4 words and the smallest .2 of a word. The epileptic boys made more words than the epileptic girls in two sittings, and less in three, the greatest difference amounting to 1.9 and the least to .2. Curiously, the normal boys built more words in seven ages and the normal girls in only four ages, based on the sex averages for all the sittings (last column). Among the epileptics the girls did better in only two ages and the boys in four.

The capacity for word construction, based on the averages for all the sittings, increased in seven of the ascending ages and decreased in three ages, namely, in ages 9, 14 and 16, in which 57%, 63% and 75%, respectively, of the children were classed as dull and average. The difference between the youngest and the oldest groups of subjects amounts to 12.6 words (15.6–3.0 words), the lowest score being made by the youngest group and the highest score by the oldest group.

Two epileptics did not construct a single word in four sittings, two failed in three sittings, six in two sittings and seven in one sitting, i. e., 56% of all the epileptics failed in one or more sittings. Only one normal (No. 5) failed to make any score in all five sittings, while one failed in one sitting, which is only 2.6% of all the normals.

COMPARATIVE IMPROVEMENT

The absolute average improvement per pupil in the second trial over the first trial with the combination a e o b m t amounted to 2.0 words for the normals and .5 of a word for the epileptics. The relative improvement (based on the index) amounted to 41% for the normals and 62% for the epileptics. The index for the epileptics, however, is exaggerated partly

because of the abnormally large gains made by two or three pupils and partly because of the inability to compute some of the indices. The absolute average improvement in the second trial over the first trial of the combination e a i r l p amounted to 1.2 for the normals, and .5 of a word for the epileptics. The relative improvement (based on the index of improvement) amounted to 18% for the normals, while the epileptics, curiously, lost 17%. The index of improvement for the epileptics, however, is not reliable owing to the fact that the index could not always be calculated for reasons that are apparent on an inspection of the table. The average gain for the two trials of e a i r l p was .8 higher than the average for the two trials of a e o b m t for the normals, but .4 lower for the epileptics. The corresponding index of gain was 21% for the normals and 7% for the epileptics. The differences between the averages of these two sets are not very large.

The absolute gain in the second trial compared with the first trial for the combination a e o b m t was greater for the normal girls by 1.2 words than for the normal boys, and greater for the epileptic boys by .2 of a word than for the epileptic girls. The index of gain was 12% greater for the normal girls than for the normal boys, and 9% greater for the epileptic girls than for the epileptic boys. With the combination e a i r l p, the absolute gain in the second trial was greater for the normal girls by 1.2 words than for the normal boys, while it was greater for the epileptic boys by .8 of a word than for the epileptic girls. The index of gain was 6% greater for the normal boys than for the normal girls, and 82% greater for the epileptic boys than for the epileptic girls.

6. CONCLUSIONS

1. The epileptics' capacity for word-building amounted to less than one-third of the normals' capacity. The epileptics' inferiority may have been partly due to their limited vocabulary—we have found in earlier tests that many epileptics experience great difficulty in finding the proper names even for very common objects—and their inability to spell correctly, but it was probably most largely due to their lower average of intelligence.

2. The capacity for constructing words varies considerably with individuals. Omitting No. 5, the variations for the normals were as follows in the different sittings: sitting 1, from 0 to 18 words; sitting 2, from 2 to 22; sitting 3, from 1 to 20 words; sitting 4, from 1 to 23; and sitting 5, from 1 to 18 words. The corresponding variations among the epileptics are as follows: sitting 1, from 0 to 11; sitting 2, from 0 to 9; sitting 3, from 0 to 7; sitting 4, from 0 to 9; and sitting 5, from 0 to 11.

The differences between the lowest and the highest number of words in each age for the normals, based on the averages for all the sittings (1–5), are as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	4.5	3.9	5.7	8.0	9.7	10.7	7.8	10.8	4.2	9.8	3.8

3. The normal pupils did best with the combinations e a i r l p and the epileptics with o e a s d n (although the score was the same in the second trial of a e o b m t). In the combined results of Anderson and Pyle, as given by Whipple, the older groups of normal pupils did better with e a i r l p than with a e o b m t, while the opposite seemed to be the case with the younger pupils. The extreme difference between the general averages in our different sittings amounted to about two and a half words for the normal pupils and one word for the epileptics.

4. Both the normals and the epileptics constructed more words during the second than during the first trial of a e o b m t and e a i r l p, probably due to practice.

5. The normal girls slightly excelled the normal boys in word-building, while the epileptic boys excelled the epileptic girls. In the combined curves of Anderson and Pyle, as given by Whipple, the normal girls were also found superior to the normal boys.

6. The capacity for word-building increases with increasing chronological age, our exceptions being unimportant in view of the limited number of cases. The oldest group built five times as many words as the youngest group. This conclusion is in harmony with the combined results of Anderson and Pyle.

7. The normal pupils made a larger absolute gain in the second trials of the two sets of letters than did the epileptics. The comparison of the relative gains, however, is not reliable, for reasons already given.

8. Although the results are somewhat discrepant, the normal girls made greater gains in the second trials of the same letter sets than the normal boys, while the epileptic boys gained more than the epileptic girls.

9. Although this test is largely limited to those who can write and spell, experimental facts (particularly the increase with age) and theoretical considerations indicate that it is a valuable test of intelligence; but we cannot say from our results that, even in an improved form, the test would be equally serviceable for measuring the development of intelligence in the same individual during successive stages. Our belief, however, is that it would have considerable value for this purpose.

XI. SENTENCE CONSTRUCTION

Building Sentences from Three Supplied Words: J1 to J5

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

Three words were printed in 10 point type at the top of the test blanks, 4 x 7.5 inches, as indicated below (J6 was not given). The words used in the first, third and fifth sittings were nouns; and those used in the second and fourth sittings verbs. No preliminary tests were made to determine whether these different sets of words were equally difficult—that is to say, whether an equal number of sentences could be constructed with the different combinations of words in the same amount of time. No assumption is made that they are uniform in difficulty, and accordingly no index of improvement has been computed, except between the averages of the first two sets of nouns and the averages of the two sets of verbs.

grass	man	bird
		J1
see	throw	find
		J2
sled	boy	book
		J3
hit	cry	jump
		J4
tree	girl	boat
		J5
wish	run	sing
		J6

2. NATURE AND PURPOSE OF THE TEST

First suggested by Masselon in 1902, this test has been used as a test of literary imagination, or "linguistic invention." It may be classified among the so-called "combination" tests, because the problem consists essentially of integrating discrete elements into a unified totality; that is, of constructing a sentence which shall incorporate the three words. In order to be able properly to do this, the subject must know the meaning of the different words, he must know what is meant by a sentence, he must be able to conceive of as many relationships between the words as possible, he must be able to express these conceived relationships in intelligible sentences, and under the conditions of the test as here administered, he must be able to write the

sentences. He must be able to resist distraction, or keep his attention on the problem and to work rapidly. All this calls for information, insight, resourcefulness, inventiveness, imagination, concentration, and judgment, or, in a word, intelligence. As a test of intelligence it would appear that the scoring cannot be based purely on the number of sentences written, because subjects who write long, complex sentences might not, just because of this fact, be able to write as many sentences as those who write brief sentences, although Stella E. Sharp found that the pupils who write the greatest number of sentences also write the most elaborate ones. Again, some subjects write significant, logically articulated sentences, showing a high degree of constructive capacity, while others write rather barren, unimaginative and poorly constructed sentences. A satisfactory scoring should take into account both the quantitative and the qualitative aspects. We have, however, not made a qualitative appraisal of the replies in this experiment. The scores in Tables 33 and 34 are based purely on the number of sentences which were written. We found some sentences which contained only one or two of the three words. No credit has been given for these sentences. We had hoped later to make a qualitative analysis of the sentences, but the inaccessibility of the original data makes this impossible. We sometimes found a considerable difference in the quality of the sentences. Some of the older children would, we believe, have written more sentences, had they written more of the short, simple types and fewer of the long, complex ones, although Sharp's results do not seem to indicate this.

3. DIRECTIONS FOR GIVING THE TEST

Time: Exactly three minutes. Place the papers with the three words (nouns or verbs) on the desks upside down. The pupils should sit with folded arms so that they cannot turn the papers over until instructed to do so.

Instructions to the Subjects: "On the other side of the papers you will find at the top three words. I want you to use these words in as many sentences as you possibly can. You can use any other words that you desire; you can place the words anywhere in the sentences; but you must be sure to use all three words in every sentence. You can use any form of the words that you like: e. g., plural or singular, nominative or possessive of nouns, or the past, present of future of the verbs. Let me give you an illustration. Suppose we have the words: *New York, river, money.* (Place these words on the board.) We could make such sentences as these: 'A New York girl crossed the river to spend her money in Brooklyn.' Or, 'I found some money along the Hudson River in New York.' Write on both sides of the paper if necessary, and ask for another sheet if you need it. You can make short or long sentences as you like."

"Now, ready!" "Turn your papers."

"Now, stop!" "Sign your names."

Scoring: Quantitative: Record the number of sentences (a) containing all three of the words, (b) two of the given words, and (c) one of the words.

Qualitative: Evaluate the quality of the sentences, possibly on a qualitative scale of 1 to 5.

4. TABLES

TABLE 33

Sentence Construction from Three Supplied Words: Jl to 5.

Sitting 1: grass, man, bird. Sitting 2: see, find, throw.

Sitting 3: sled, boy, book. Sitting 4. hit. cry, jump.

Sitting 5: tree, girl, boat.

NORMAL CHILDREN

No.	Ae.	Sx.	1 No.	2 No.	3 No.	4 No.	5 No.	1-3 Ave.	2-4 Ave.	$f\,{}^{2-4}_{1-3}$	Ave. 1-5
1	7	B	0.	0.	1 0	.5	5	5	.2	.50	.4
2	7	G	2.	2.	3.	2.5	4.	2.5	2.2	90	2.7
4	7	Av.	1.	.6	2.	1.5	2.2	1.5	1.2	.76	1.5
8	8	B	1.6	.5	1.6	1.6	1.6	1.6	1.0	.58	1.4
3	8	G	1.3	.6	.6	.3	1.6	1	.5	.37	.9
11	8	Av.	1.5	.5	1.3	1.2	1 6	1.4	.9	.73	1.3
3	9	B	1.3	.0	1.	.3	1.6	1.1	.1	.2	.9
4	9	G	1.7	.7	2.	1 2	3.	3.	1.	.36	1.7
7	9	Av.	1.5	.6	1.5	.8	2.4	2.5	.6	.32	1.4
4	10	B	3.6	3.	3.6	3.	3.7	3 6	3.1	.89	3.4
3	10	G	2.6	2.6	2.	4.	4.6	2.3	3.3	1.50	3.2
7	10	Av.	3.1	2.8	2.8	3 4	4.1	3.1	3.2	1.15	3.3
3	11	B	3 6	2.	3.6	3.	3 3	3.	2.5	.96	3.4
8	11	G	4.2	2.7	6.0	5.6	5.8	5.1	3.5	.67	4.6
11	11	Av.	4.1	2.4	5.3	3.9	5.1	4 5	3.2	.75	4.3
5	12	B	3.	1.8	4 2	2.	4.2	3.6	2.0	.53	3.1
3	12	G	2 6	3.3	5.	2.3	5.	3.8	2,8	.58	3 9
8	12	Av.	2.8	2.3	4.5	2.1	4 5	3.5	2.3	.77	3.4
4	13	B	3.3	4.3	6.2	4.5	5.7	4.7	5 1	1.14	4.7
2	13	G	4.0	2.5	4.5	3.0	4.5	4.2	2.7	.59	3.7
6	13	Av.	3.5	3 6	5.6	4.0	5 3	4 6	3.5	.92	4.4
4	14	B	4	4.3	6.5	4 6	6.	5 2	4.3	.93	5.0
7	14	G	5	4.7	7.6	4.3	6.5	5.9	4.5	.77	5.4
11	14	Av.	4.6	4.6	7.1	4 4	6.4	5.7	4.4	.83	5.3
2	15	B	9.	8.	13.	7 5	11.5	9.7	7.7	.80	9.3
2	15	G	7.	4 5	7.5	6.5	8.5	7.2	5.5	.78	6 8
4	15	Av.	8.	6.1	9.3	7.	10.	8.5	6.6	79	8 0
1	16	B	7.	5.		6.	6.	7.	5.5	.78	6.0
3	16	G	7.	7.5	9.6	7.3	8.6	8.3	7.1	.86	8 0
4	16	Av.	7	6.6	9.6	7	7 5	8	6 7	.83	7.5
1	17	B	6.	4.	5	3	5	5.5	3.5	.63	4 8
2	17	G	6.5	7.	8.5	7.	7.	7.5	7.	.93	7.2
3	17	Av	6.3	5 5	7.3	5.6	6.3	6.5	5.8	.83	6.4
Average	B		3.1	2.4	3 8	2 5	4.0	3.4	2.6	.83	3 2
Average	G		4.0	3 3	5.2	3.8	5.4	4.5	3.5	.77	4 3
Average	B and G....		3.5	2.8	4 5	3.3	4.7	4.0	3.1	.80	3.8

TABLE 34

Sentence Construction from Three Supplied Words: J1 to 5.

Sitting 1: grass, man, bird. Sitting 2: see, find, throw.

Sitting 3: sled, boy, book. Sitting 4: hit, cry, jump.

Sitting 5: tree, girl, boat.

EPILEPTICS

Su.	Age	Sex	1 No.	2 No.	3 No.	4 No.	5 No.	1-3 Ave.	2-4 Ave.	$f\frac{2-4}{1-3}$	Ave. 1-5
81	10	B	1.	....	..	1.	1.	1.	1.	1.00	1.
102	10	G	3.	0.	0.	3.	0.	1.5	1.5	1.00	1.2
104	10	G	2	0	3.	0.	2.	2 5	0.	.00	1.4
		Ave.	2.5	0.	1.5	1.5	1.	2.0	.7	.50	1.3
99	11	G	0.	[illegible]	0.	.	0.	0.	0.	...	0.
79	12	B	1.	0.	1.	0.	1.	1.	0.	.0	.6
84	12	B	3.	0.	3.	3.	4.	3.	1.5	.5	2.6
91	12	B	0.	0.	0	0	0.	0.	0.	..	0.
		Ave.	1.3	0.	1.3	1.	1.6	1.3	5	.25	1.0
108	12	G	0.	0.	...	0.	0.	0.	0.	....	0.
93	13	B	0.	0.	..	0.	0.	0.	0.	....	0.
86	13	B	0.	0.	0.	1.	0.	0.	.5	....	.2
	....	Ave.	0.	0.	0.	.5	0.	0.	.2	....	.1
97	13	G	1.	0.	1.	...	2.	1.	0.	0.	1.0
77	14	B	4.	1.	1.	2.	4	2.5	1.5	.60	2.4
89	14	B	1.	0	1.	1	0.	1	.5	.50	.6
		Ave.	2.5	.5	1.	1 5	2.	1.7	1.0	.55	1.5
80	15	B	0.	0	2.	1.	1.	1.	.5	.50	.8
82	15	B	0.	0.	2.	1.	2.	1.	.5	.50	1.0
83	15	B	0.	0	0	0.	0.	0.	0.	....	0.
	....	Ave.	0.	0.	1.3	.6	1.	.6	.3	.50	.6
103	15	G	0.	0.	0	0.	0	0.	0	...	0.
78	16	B	0.	0.	1.	0.	0.	.5	0.	.00	.2
88	16	B	2.	3.	3.	3.	3	2.5	3	1.20	2.8
85	16	B	3.	1.	3.	1.	2.	3.	1.	.33	2
....	..	Ave.	1.6	1.3	2.3	1.3	1.6	2.0	1.3	51	1.6
96	16	G	0.	0.	0.	0.	0.	0.	0.	....	0.
98	16	G	2.		0.	0.	0.	1.	0.	.00	0.5
105	16	G	0.	0.	0.	2.	2.	0.	1.	....	.8
100	16	G	0.	0.	0.	0.	0.	.	....	.	0.
	....	Ave.	.5	0.	0.	.5	.5	.2	.3	.00	.2
87	17	B	0.	....	0.	.	....	0.	..	.....	0.
90	17	B	0.	0.	0.	0.	0.	0.	0.	....	0.
....	....	Ave.	0.	0.	0.	0.	0.	0.	0.	...	0.
95	17	G	0.	0.	..		0.	0.	0.	....	0.
105	18	G	2.	0.	0.	0.	0.	1.	0.	.00	.4
107	21	G	0.	0.	0.	0.	0.	0.	0.	....	0.
101	24	G	0.	0	0.	0.	0.	0.	0.	....	0.
Ave. Boys			.9	.3	1.2	.9	1.2	1.0	.6	.51	.9
Ave. Girls			.7	0.	.3	.4	4	.5	.2	.20	.3
Ave. Boys & Girls			8	.1	.8	.7	.8	.5	.4	.40	.6

5. RESULTS (See Tables 33 and 34)

The average number of sentences constructed in all the sittings (last column in the tables) was 3.8 for the normals and .68 of a sentence for the epileptics. The epileptics built only 17.9% as many sentences as the normals. The epileptics did only 45% as well as the youngest group of the normals and only about 10% as well as the oldest group of normals. Eight of the epileptics were unable to construct a single sentence in five sittings, six in four sittings, four in three sittings, six in two sittings, and two in one sitting. In other words, 86% of all the epileptics failed in one or more sit-

tings. Seven of the normal pupils failed completely in all five sittings, one in three sittings, two in two and sixteen in one. Thirty-four per cent of the normal pupils failed in one or more sittings. Of course, this large difference may not be due wholly to the poverty of the epileptics' "linguistic imagination," or their inability to construct the sentences, but also to the difficulty of writing the sentences.

Both the epileptic and the normal pupils wrote more sentences with the nouns than with the verbs. The difference between the averages for the sentences in sittings 1 and 3 (nouns) and 2 and 4 (verbs) amounts to .9 of a sentence for the normals and .1 of a sentence for the epileptics. The difference is slightly greater, both absolutely and relatively, for the normal than for the epileptic children, although this does not seem to be the case from the index of loss in $f\frac{3-4}{1-3}$. According to the indices, the normals did 20% poorer with the verbs than with the nouns, while the epileptics did 60% poorer. But many of the indices could not be computed for the epileptics, because of the negative scores, whence the epileptics' indices are not very reliable.

The normal boys constructed only 74% as many sentences as the normal girls, or 1.1 sentences less each, based on the averages for all five sittings (last column), while the epileptic girls wrote only 40% as many sentences as the epileptic boys, or .54 of a sentence less each. The normal girls did better than the normal boys in every sitting, the greatest difference between the general averages amounting to 1.4 sentences in sittings 1 and 5 (nouns) and the least difference to .8 of a sentence, in sitting 1. On the other hand, the epileptic boys surpassed the epileptic girls in every sitting, the greatest difference being .9 of a sentence, in sitting 3, and the smallest difference .2 of a sentence in sitting 1. Based on the sex averages for the different ages for all the sittings (last column), the girls excelled in seven ages and the boys in four among the normal pupils and the boys in three ages and the girls in two among the epileptics, the averages being the same in one age.

Based on the age averages for all the sittings (last column) for the normal children, there was an increase in the number of sentences written in six of the ages and a decrease in four, namely in ages 8, 12, 16 and 17, in which, respectively, 72%, 62%, 75% and 100% of the pupils were classed as dull and average. The difference between the averages of the youngest and the oldest group amounts to 4.9 sentences. The highest score, however, was made by the fifteen-year group and the lowest by the eight-year-olds.

6. CONCLUSIONS

1. The normal pupils were more than five times as efficient as the epileptics in this test of sentence construction. We imagine that the epileptics would have done somewhat better relatively had the responses been verbal

instead of written. The test was too difficult for some of our normal and epileptic cases. Binet placed a similar test in age X. Our normal ten-year-olds do more than twice as well as the children in any of the younger ages.

2. The individual variations were considerable in the ability to construct sentences, under the conditions of this test. Among the epileptics the number of sentences varied as follows in the different sittings: in 1, from 0 to 4; in 2, from 0 to 3; in 3, from 0 to 3; in 4, from 0 to 3; and in 5, from 0 to 4. Among the normals the variations for children from 7 to 17 were as follows: in 1, from 0 to 10; in 2, from 0 to 9; in 3, from 0 to 13 ;in 4, from 0 to 10; and in 5, from 0 to 12. The difference between the poorest and the best records in each age among the normals, based on the average of all five sittings (1–5), was as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	2.8	3.2	4.0	1.6	4.6	2.9	4.4	3.4	3.6	3.8	2.4

3. Both the normals and the epileptics wrote more sentences with the nouns than with the verbs, a result in harmony with Sharp's findings, although she says that the sentences with the verbs were better in quality.

4. The normal girls did appreciably better than the normal boys, while the epileptic boys did decidedly better than the epileptic girls, in the construction of sentences.

5. The ability to construct sentences increases with ascending age among the normal children. The oldest group of pupils built more than four times as many sentences as the youngest group. The exceptions which we find are to be attributed to a preponderance of dull and average pupils in certain ages and to the fewness of the subjects.

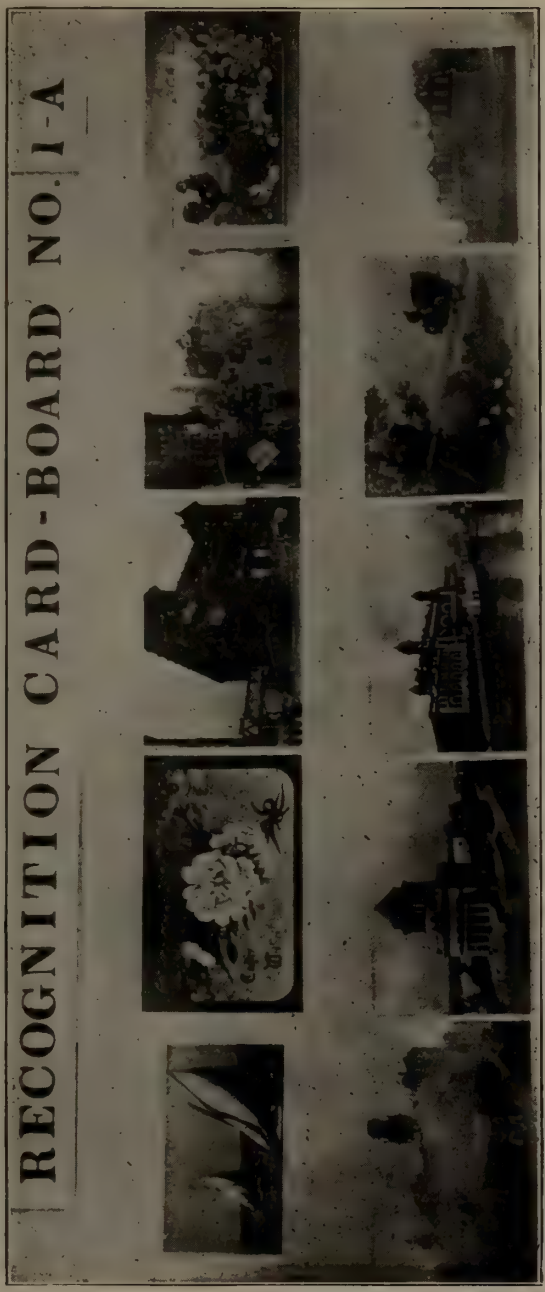
6. Our experience with this test, both when given to groups of children and when given clinically (as in the Binet scale), has uniformly pointed to its value as a test of intelligence. In clinical examinations we have found verbal responses preferable to written responses, especially when the subject is asked to make only one sentence, as in the Binet test. The test, however, is too difficult for seven or eight-year-old children.

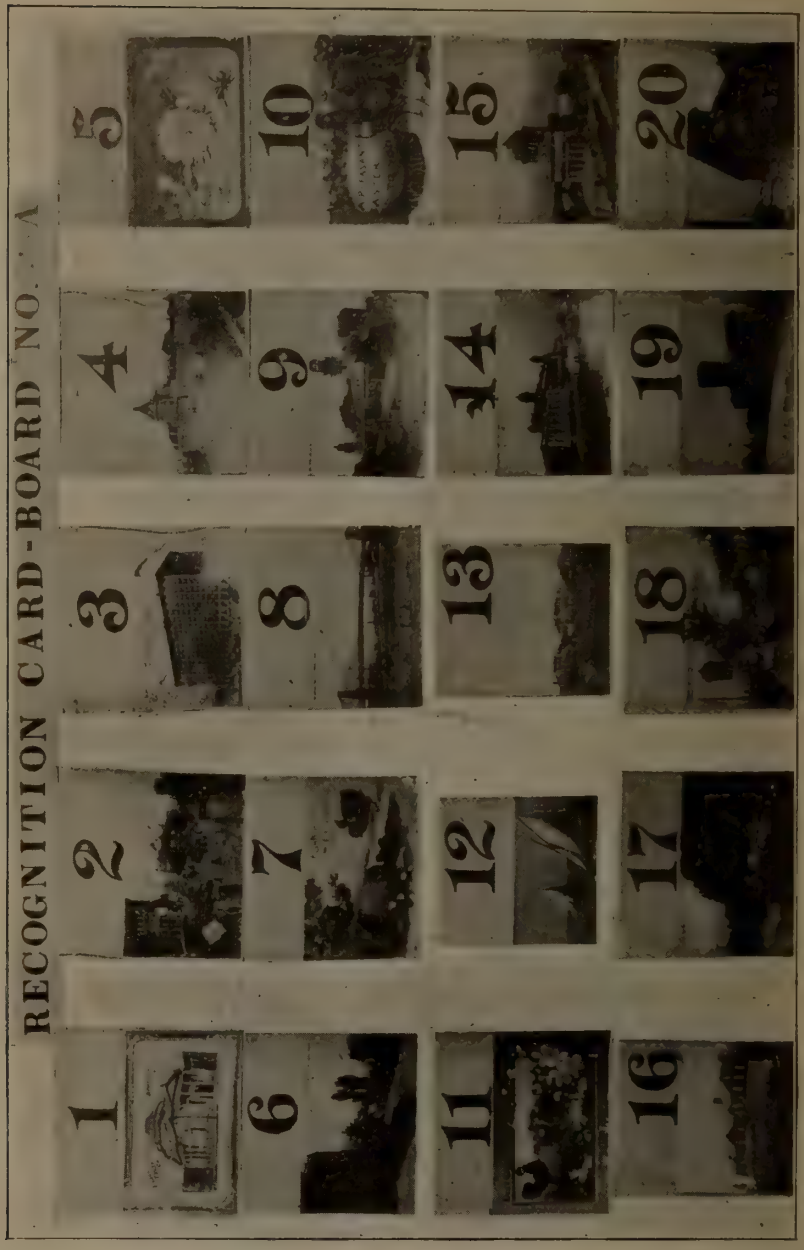
XII. RECOGNITION

Recognition of Illustrated Post Cards: K4

1. REPRODUCTION AND DESCRIPTION OF TEST MATERIALS

The test materials consisted of two sets of illustrated post cards, pasted on white cardboards, 22 x 28 inches; first, the stimulus set, No. 1-A, which contains 10 post cards; and, second, the recognition set, No. 2-A, which contains twenty post cards. Ten of the post cards on 2-A are exact duplicates of the cards on 1-A. The imperfections which appear in the photographic reproductions, from which the cuts on pages 147 and 148 are made, did not appear on the post cards themselves. On the other hand, ten of the post cards on 2-A are new. The post cards on 2-A were numbered consecutively from 1 to 20, while the cards on 1-A were not numbered. The post cards were made from unusually clear prints and, together with the numbers, were easily visible from any seat occupied by the examinees. Parallel sets of cards, 1-B and 2-B, were constructed, but we were unable to use these. Cardboard 1-A (the stimulus card) was exhibited for 20 seconds at the beginning of the sitting (before test A-4 was given), while 2-A (the recognition card) was exposed for 90 seconds at the end of the sitting (after test L), about an hour later, in accordance with the procedure described in section 3, below.


RECOGNITION CARD-BOARD NO. 1-A


RECOGNITION CARD-BOARD NO. A
1
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20

2. NATURE AND PURPOSE OF THE TEST

In this test the subject is asked to examine very carefully the cards on 1-A, so that he will have them thoroughly "fixed in his mind." After the proper interval he is asked to scrutinize the cards on 2-A, and determine which of the cards appeared on 1-A. Obviously success in the test is dependent upon the subject's ability (1) to observe accurately the characteristics of each post card, to note points of difference and resemblance between them, particularly the cluster of attributes which makes one card differ from any other card; (2) upon his ability to retain the impressions received from the inspection of the cards with their associated images; and (3) upon his ability to identify the original cards when later presented in a different setting among an equal number of strange cards, some of which resemble the original cards more or less closely. Incidentally, success may also depend on the ability to perceive and record correctly the numbers of the cards. Such a process of conscious identification of the individual's present experience with his past experience is known as "recognition," and is said to rest upon a feeling of "familiarity." It is evident that the more the cards on 1-A are like the new cards on 2-A, or the less distinctive the cards are on 1-A, the more difficult will be the process of recognition. Thus the second card (flower) on 1-A, can easily be recognized on 2-A, because the flower stands out distinctly and no other card on 2-A closely resembles this card. On the other hand, the houses on post cards 9 and 20 might very easily be confused. The difficulty of the test can be very greatly increased by using cards which are quite similar in appearance, and, also by lengthening the interval of time between the original impression and the recall. In the fourth sitting the interval was only one hour (we shall discuss these results under the designation of "immediate recognition"), while in the fifth sitting it was one month ("deferred recognition" of the cards displayed one month earlier).

Success in the test, then, depends upon the individual's degree of active attention, keenness of observation and power of retention. The strength of these factors, in the large, probably varies with general intelligence.

3. DIRECTIONS FOR GIVING THE TEST

Time: 20 seconds for the exposure of the stimulus set (1-A); 90 seconds for the exposure of the recognition set (2-A), during which time the subjects make their records on plain sheets of paper.

Directions: At the beginning of the experimental period the experimenter, without further notice, made the following announcement:

"I am going to show you some post cards on the other side of this cardboard (stimulus set, 1-A). I want you to look very carefully at the cards, so that you will get a good impression of each one of them. Try to fix them

in your minds as well as you can. I will only allow you a short time in which to look."

"Now, ready!" (Turn the cardboard rapidly and expose the cards for 20 seconds.)

The following statement was then made:

"A little later I shall ask you to do something with the cards."

At the end of the hour, the experimenter proceeded.

"Now I shall show you a set of cards which includes all the cards which I showed you before, and also a number of new cards. Each post card is numbered. The number is written above the card. What I now want you to do is to look the cards over carefully when they are exposed and write down the numbers of all the cards which I showed you before. If card 1 was shown before, write the figure 1; if card 2 was shown, write the figure 2, etc. Do not write the figures of cards which were *not* shown before."

"Now, ready!"

"Now, stop. Turn your papers. Sign your names."

Scoring: For percentage of efficiency, score 10% for each post card correctly recognized. Record the number of cards mistakenly recognized. A proper deduction may be made for mistaken recollections, but this was not done in this experiment (except when all the numbers were written). The announcement that a deduction will be made for all wrong numbers written would probably tend to make the subjects more cautious and lessen the tendency to write all the figures or a large number of figures at random. It is evident that when no deduction is made for wrong numbers a very poor child could make a perfect score by writing all the numbers. We had to give a zero score to ten of the epileptics and four of the normals (three in the second and one in the fourth grade), because they wrote all the numbers. A considerable number of pupils wrote several wrong numbers, although we emphasized the fact that only the numbers of the cards recognized as having been shown before should be written. Most of the pupils who wrote wrong numbers, however, probably made honest mistakes.

Another method of discouraging the tendency of writing too many numbers at hap-hazard is to tell the subjects that not more than ten numbers may be written. This was not done in this experiment. One of our epileptics wrote 11 numbers, one 12, and one 13, all in the deferred test. Three of the normal pupils wrote 11 numbers, three 12 and one 13, in the immediate test, and four wrote 11 and one 14 numbers in the deferred test. It is evident that these pupils reaped an unjust advantage. The number of cards wrongly remembered is recorded in the tables in the "W" column.

4. TABLES

TABLE 35.

Recognition of Illustrated Post Cards: K4

NORMAL CHILDREN							EPILEPTICS						
No.	Age	Sex	4 %	No. W.	5 %	No. W.	No.	Age	Sex	4 %	No. W	5 %	No. W.
1	7	B	30.0	2.	25 0	4.	81	10	B	0.	...	80.	4
2	7	G	70.0	1.	50.0	4	102	10	G	10.	1	0.	0.
4	7	Ave.	50.0	1.3	37.5	4.	104	10	G	40.	3	20.	0
7	8	B	54.3	2.	47.1	3.4	....	....	Ave.	25.	2	10.	....
3	8	G	56.2	3.6	56.0	3.6	79	12	B	0.[1]	....	0.[1]	....
10	8	Ave.	55.0	2.5	50 0	3.5	84	12	B	80.	1	80.	3
3	9	B	43.3	1.3	46.6	3 6	91	12	B	0.1	....	50.	4
4	9	G	42.5	2.3	42 5	2.6	....	....	Ave	26.6	...	43.3	3.5
7	9	Ave.	42.8	2.2	44.2	3 2	108	12	G	0.1	....	0.1	....
4	10	B	77 5	1	60.0	1.	93	13	B	0.1	....	0.1	....
3	10	G	70.0	1.6	66.6	2.3	[illegible]	13	B	0.1	...	10.	1
7	10	Ave.	74.5	1.3	62.8	2.7		....	Ave.		....	5.	
3	11	B	50.0	2.	30.0	3.3	77	14	B	90.	0	70.	2
8	11	G	62.5	1.7	48.5	1.8	[illegible]	14	B	40.	2	40.	6
11	11	Ave.	59 1	1 8	42.0	2 3	..	....	Ave.	65.	1	55.	4
5	12	B	67.5	1.5	62 5	3.7	80	15	B	30.	2	60.	4
3	12	G	76 6	1.	60.	2.6	82	15	B	70.	3	80.	5
9	12	Ave.	71.4	1.3	61.4	3.3	83	15	B	30.	2	10.	0
4	13	B	57.5	2.7	55.0	3.3		....	Ave.	43.3	2.3	50.	3
2	13	G	60.0	1 0	60.0	2.0	103	15	G	0.	0	0.	0
6	13	Ave.	58 3	2.1	56.6	2.8	78	16	B	10.	0	0.	....
4	14	B	76 6	.6	70.	1.5	88	16	B	40.	1	50.	5
7	14	G	74.3	.8	61.4	1.5	85	16	B	0.1	....	0.1	....
11	14	Ave.	75.0	.8	63 3	1.5	....	....	Ave.	16.6	.5	16.6	
2	15	B	80.0	1 5	70.0	2.5	96	16	G	0.	0	0.	0
2	15	G	80 0	1	65.0	3.5	98	16	G	10.	3	0.	....
4	15	Ave.	80.0	1.2	67 5	3.0	106	16	G	0.1		30.	1
1	16	B	80.0	0.	60.0	1	100	16	G	40.	5	0.	2
3	16	G	86.0	1.6	63 3	3.			Ave.	12.5	2.6	7.5	.7
4	16	Ave.	85.0	1.3	62.5	2.5	87	17	B	0.1	....	0.1	
1	17	B	70.0	3	40.0	4.	90	17	B	0.	0	0.	0
2	17	G	85.0	0.	75.	2.5	95	17	G	0.	0	0.	0
3	17	Ave.	80.0	1.	63.3	3.	105	18	G	0.1	..	0.1	...
							107	21	G	0.1	....	30.	2
Ave. Boys ...			60.8	1.7	51.5	3.1	101	24	G	0.	0	0.	0
Ave. Girls			67.9	1.5	57.3	2.4							
Ave. Boys & Girls			64.6	1.6	54.6	2.8	Ave. Boys			24.3	1.2	33.1	2.8
							Ave. Girls....			8.3	1.5	6.6	.5
							Ave. Boys & Girls			17.5	1.3	21.7	1.7

No. W. indicates the number of post cards wrongly recognized.

[1]Wrote all the numbers consecutively, hence given a zero score. None of these subjects was considered in the column containing the wrong numbers.

5. RESULTS (See Table 35)

IMMEDIATE RECOGNITION

The normal pupils correctly recognized on the average six and a half cards (which gives a score of 64.6%), while the epileptics' average was one and three-fourths cards (which gives a score of 17.5%). In power of visual recognition the epileptics did only 27% as well as the normal children. They did only 35% as well as the youngest group of the normals and not quite 22% as well as the oldest group of normals. Fifteen epileptics failed entirely (ten of these, however, because they wrote all the numbers), and four of the normal pupils (all of whom wrote all the numbers).

It is probable that the epileptics' average is slightly too low, because of the losses incurred through the ten pupils who recklessly wrote all of the numbers and who were given zero scores. It is evident that some of these subjects must have been able to recognize some of the cards. This is indicated by the fact that the average for the epileptics in the deferred recognition test, which was given one month later, is actually higher. The pupils were then explicitly told that many had written all the numbers in the previous test and that this must not be repeated.

Two normal pupils (girls, aged 14 and 16) had all ten cards correct. No epileptic made a perfect score, but one recognized nine cards correctly and one eight cards.

The normal boys recognized 89% as many cards as the normal girls, or seven-tenths of a card less each. On the other hand, the epileptic girls recognized only 34% as many cards as the epileptic boys, or about one and a half cards less each. Among the normal pupils the girls excelled the boys in seven ages, the boys excelled in three ages, while the scores were the same in one age. Among the epileptics the girls did better in only one age, the boys in three ages, while the scores were equal in the remaining age that could be compared.

The ability to recognize the cards increased in six ages, while there was a decrease in four ages, namely, in ages 9, 11, 13 and 17, in which, respectively, 57%, 72%, 50% and 100% of the pupils were rated as average and dull.

The average number of wrong numbers recorded was 1.6 for the normal pupils and 1.3 for the epileptics, a difference of .3 of an error. The normal pupils made 25% more mistaken recognitions than the epileptics, while the epileptics made only 27% as many correct recognitions as the normal pupils. It must not be forgotten that we are not including the records of the errors of those subjects who wrote all the 20 numbers. Had these been included the epileptics' average number of errors would have been much larger. Moreover, the number of wrong cards given should be considered in relation to the number of right cards given. The average number of wrong recognitions made by the normals amounted to only 24% of the average number of right recognitions (6.46), while the average number of errors made by the epileptics amounted to 74% of the average number of cards they had right (1.75). Relatively to their degree of efficiency the normals made fewer errors than the epileptics.

The normal girls made 88% as many false identifications as the normal boys, or .2 of one error each less than the boys, while the epileptic boys made 80% as many as the epileptic girls, or .3 of one error each less than the girls. Among the normals the girls made less errors than the boys in six ages, while

the boys made less errors than the girls in five ages. Among the epileptics comparison was possible only in three ages.

The average number of errors increased in five ascending ages and decreased in five ascending ages among the normal pupils.

DEFERRED RECOGNITION

Without prior warning the recognition cardboard, 2-A, was shown at the beginning of the fifth sitting, and the pupils were asked to write the numbers of all the cards they were able to recall as having been shown one month earlier on the stimulus cardboard 1-A (which, of course, was not again exposed). They were allowed the same amount of time for writing as before. As has already been indicated, they were specially cautioned not to write all the numbers, but only the numbers of the cards which they beleived they saw on the other cardboard (1-A).

The normal pupils on the average correctly recognized about five and a half cards (scoring 54.6%), or one card less than in the immediate recognition. The loss in the ability correctly to recognize the cards during the lapse of one month thus amounted to 16%. The epileptics recognized on the average a little over two cards (scoring 21.7%), or almost half a card more than in the immediate recall. The epileptics gained 24%, while the normal pupils lost 16%. In the immediate recall the epileptics did only 27% as well as the normals, but in the deferred recall they did 39% as well. The gain made by the epileptics, however, is, we believe, spurious. They did better in deferred recognition, not because of any increase in the power of recognition, but partly because they were specially cautioned not to write all the numbers, which would deprive them of all credit, but only the numbers of the cards actually exhibited on cardboard 1-A. Subjects 91, 86, 106 and 107 profited by this advice, while 79, 108, 93, 85, 87 and 105 did not, including 78, who wrote all the numbers, although he did not do so the time before. One subject, 81, made no score in the immediate recognition test (returning a blank page), while he got eight cards correct in the deferred recognition test. It will be seen, however, that he wrote twelve numbers. Two other subjects, 82 and 84, wrote over ten numbers. Two of these three subjects made a higher score in the deferred test.

The greatest number of cards correctly recognized was eight, namely, by nine normal pupils and three epileptics—all of the epileptics, however, wrote too many numbers.

The normal boys did almost 90% as well as the normal girls, recognizing on the average fifty-eight hundredths of a card less than the girls. The girls excelled in seven ages and the boys in four. We found the girls superior in the immediate recall approximately in the same ratio. On the other hand, the epileptic girls did only about 20% as well as the epileptic boys, recogniz-

ing on the average two and a half cards less than the boys. The epileptic boys excelled in four ages, while the scores were the same in the other age which could be compared. Relatively the epileptic girls did markedly better in the immediate recognition than in the deferred recognition.

The ability to recognize the cards increased in six ages and decreased in four ages among the normals, just as in the case of the immediate recall. Three of the ages showing a decrease were the same as in the immediate recognition, while age 16 showed a decrease in the deferred recall instead of age 17.

The normal pupils wrote on the average 2.8 wrong numbers, or 1.2 more than in the immediate recall. In other words, they made 75% more errors in the deferred than in the immediate recall. The epileptics averaged 1.7 wrong numbers, or .4 of an error more than in the immediate recall. They made 30% more errors than in the immediate recall. The errors of the normals amounted to 51% of the score they made in the deferred recall (5.46), while the errors of the epileptics amounted to 78% of their score (2.17). Relatively to the degree of efficiency which they showed, the normal pupils made less errors than the epileptics, but the epileptics did better relatively in the deferred recall than in the immediate recall, probably due to the greater care taken and to the inclusion of records which could not be considered in the earlier test.

The normal girls made 77% as many mistakes as the normal boys, or on the average .7 of one error less. The normal girls made less errors in six ages than the normal boys, the boys made less errors than the girls in three ages, while the results were the same in two ages. Relatively to the boys, the normal girls made less errors in the deferred than in the immediate recall. The epileptic girls made only 18% as many errors as the epileptic boys, although in the immediate recall they made 20% more errors than the boys. Since, however, only three girls made a score in the deferred test, while eight either wrote nothing at all or wrote all the numbers (which thus were rejected) in the immediate recognition test, the comparative results are not reliable.

INTROSPECTIONS ON THE DEFERRED RECOGNITION

The two sections containing the oldest normal children were asked to indicate how they were able to recognize the post cards which had been presented a month earlier on 1-A, whether by recalling the cards themselves—the pictures on the cards—or by recalling the numbers they wrote a month earlier, or by visual imagery, or by some other method. Thirty-nine answered that they remembered the cards themselves or the picture on the cards (one remembered only parts of the cards), while eight recalled the pictures as well as the numbers, or some of the numbers they had written.

The pupils in the oldest section of normal children were also asked to state whether or not they were certain respecting the correctness of their recognitions. Five stated that they were uncertain. But two of these who said their recognitions were "guesses" had six right and only one wrong and eight right and only one wrong, respectively. One had four right and three wrong, one five right and two wrong, and one six right and one wrong. The records of four of these pupils were much better than could have been inferred from their introspections. Six said they were uncertain of some of the post cards. Of these six three had eight right and two wrong, one had six right and four wrong, one six right and three wrong and one four right and two wrong. One who was certain of most of the cards had seven right and three wrong. One who was certain of four or five had five right and three wrong. One who was certain of only one card had four right and four wrong. One who was certain of those he gave in his answers had six right and two wrong. Of four who were certain of their judgments, two had eight right and two wrong, one had seven right and three wrong and one had five right and none wrong. On the whole, there was a considerable degree of correlation between the subjective certainty or uncertainty and the empirical results.

6. CONCLUSIONS

1. According to the empirical result the epileptics did only 27% as well as the normals in this test. This figure, however, does not correctly represent the epileptics' relative inferiority in the immediate power of recognition, owing to the fact that many subjects were given too low a score (zero) because they wrote all the numbers. At least some of these subjects would have made some score had they properly followed the instructions.

2. The ability correctly to recognize the cards after the interval of a month was appreciably weakened in the normal children—a loss of 17% in efficiency—while it was increased in the epileptics (by 24%). We have given reasons, however, why the epileptics' gain after a month's interval cannot be considered to represent a genuine improvement in the power of recognition.

3. The normal girls excelled the normal boys, while the epileptic boys decidedly excelled the epileptic girls, in the strength of recognition, both immediate and deferred.

4. The power of recognition, both immediate and deferred, tends to increase slightly with ascending age; the exceptions, which are relatively numerous, are probably explained by the limited number of subjects and the unequal distribution of pupils of different degrees of ability in the different ages. The difference between the oldest and the youngest group of children amounted to 30% in the immediate recognition and 25.8% in the deferred recognition, a difference of two and a half cards. The older pupils did 1.6

times as well as the youngest pupils in both the immediate and in the deferred test.

5. The absolute number of mistaken recognitions was larger for the normal than for the epileptic children, both in the immediate and in the deferred recognition. The reason that the epileptics made less errors is due to the rejection of the records of all the epileptics who wrote all the numbers, and to the fact that some epileptics did not write any numbers, while some wrote only four or five numbers altogether. However, when the number of wrong recognitions made is compared with the number of correct recognitions, the normal pupils made relatively far less errors than the epileptics in both the immediate and the deferred recognition. Both the normals and the epileptics made considerably more errors in the deferred recognition than in the immediate recognition.

6. The normal girls made less errors than the normal boys in both tests, but particularly in the deferred recognition, while the epileptic boys apparently made less errors than the epileptic girls.

7. There was no correlation between the number of mistaken recognitions and the chronological age of the normal children.

8. There are considerable individual differences in the ability correctly to recognize the cards and in the number of errors made. Among the epileptics the poorest individual made zero while the best one had nine cards correct in the immediate test, while in the deferred test the variation was from 0 to 8 cards. The errors varied from zero to five cards in the immediate test, and from zero to six in the deferred. Among the normal children the scores varied from zero to ten cards in the immediate test and from zero to eight cards in the deferred, while the errors varied from zero to five in the immediate test and from zero to nine in the deferred. The amount of variation in each age in the number of cards correctly recalled (the difference between the best and the poorest record) in the immediate test is as follows for the normals:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	6	9	8	3	7	3	5	4	2	3	2

9. The vast majority of the pupils interrogated based their recognitions in the deferred test merely on the memory of the pictures on the cards. Not very many pupils were certain that all their recognitions were correct. On the whole, there was a fair degree of correspondence between the subjective feeling of certainty and uncertainty and the objective results.

10. Judging by the improvement with increasing age this test would have fair value as one of a number of tests for measuring intelligence. We cannot, however, infer without further proof that one who proves to be poor in recognizing these post cards would also be poor in recognizing persons and things, although this might be so. One of the subjects in this test made a perfect score who is notorious for her ability to recognize faces.

XIII. SPEED OF MOTOR REACTION

Writing Circles: L5.

1. DESCRIPTION OF TEST

The tapping test has usually been used as a test of motor speed. In individual experiments the taps have usually been made on a telegraph key or by means of a metal stylus on an electrically connected metal plate. In group experiments dots have been made by means of a pencil on plain sheets of paper or on paper divided into 100 1-cm. squares, in each of which the subject has been instructed to place one dot. Sometimes vertical strokes have been made instead of the dots. We decided not to use the dot method, because in a brief preliminary test we found that some epileptics beat so hard as to break the graphite, while sometimes the dots were superposed so that it was difficult to count them (we preferred not to use the cross-section paper, as this would introduce a complicating factor). Moreover, it seemed to us desirable to use a more complicated manual movement than that involved in making a straight line, and so we had the subjects make circles. Making circles or curvilinear lines requires a higher degree of motor coordination than merely drawing straight lines. It gives a better combined measure of motor speed and coordination, we believe, than making strokes. However, we took pains to advise the subjects that no effort should be taken to make beautifully curved or perfect circles, as may be seen in the instructions. The methods of making strokes and making circles with a lead pencil are both subject to the difficulty that the extent of the manual movement cannot be regulated, as is the case when the telegraph key is used. Given two subjects of equal motor ability (at least qua speed), the one who makes the larger movements will necessarily make the smaller number of movements. There was considerable variation in the size of the circles made by some of our subjects. Most of those who made large circles were among our young or low grade subjects. Their scores were usually low. It is, of course, possible that their scores would have been just as low or lower had they made smaller circles, as the smaller movements might have involved more difficult motor coordinations and thus have required more time for their execution.

2. DIRECTIONS FOR GIVING THE TEST

"Just as soon as you turn your papers over, I want you to start writing O's, or making little circles like these (illustrate by making small circles on the board). Don't make the circles too large; make them about the size that you make an ordinary O. Don't make half circles; try to close them.

But don't spend any time trying to make the circles look pretty or perfectly round or go over them a second time to make them better, because you must write just as many as you possibly can. Begin at the upper left corner, and write toward the right (indicate direction of movement on sheet of paper). Don't run the O's together. Keep them separate. You will get only a short time, so hurry and make just as many circles as you can."

"Now, ready!"

"Now, stop! Turn your papers. Sign your names." (Time allowed: 60 seconds.)

Scoring: Record the number of circles made. No credit was given for curved lines which were less than half circles, but not many such lines were made. Circles were sometimes run together, but there was no difficulty in accurately counting interlaced circles.

3. TABLES.

TABLE 36.

Manual Movement Test (Writing Circles): L5.

NORMAL CHILDREN				EPILEPTICS			
No.	Age	Sex	May No.	Su.	Age	Sex	May No.
.....	.....	.....	.....	81	10	Boy	75.
2	7	Boy	68.5	102	10	Girl	70.
2	7	Girl	72 5	104	10	Girl	87.
4	7	Ave.	70.5	.....	....	Ave.	78.5
7	8	Boy	74.2	99	11	Girl	99.
3	8	Girl	69.6	79	12	Boy	71.
10	8	Ave.	32.0	84	12	Boy	113.
3	9	Boy	73 6	91	12	Boy	83
4	9	Girl	74.2	.....	...	Ave.	89.
7	9	Ave.	74.0	108	12	Girl	28.
4	10	Boy	96.0	93	13	Boy	115.
3	10	Girl	80.5	86	13	Boy	38.
7	10	Ave.	89.8	.....	....	Ave	76.5
3	11	Boy	88.6	97	13	Girl	87.
8	11	Girl	95.0	77	14	Boy	85.
11	11	Ave.	93.1	89	14	Boy	95.
5	12	Boy	103.	....	....	Ave.	90.
3	12	Girl	112 6	80	15	Boy	95.
8	12	Ave.	106.5	82	15	Boy	68.
4	13	Boy	103.	83	15	Boy	61.
2	13	Girl	118.	....	.	Ave.	74.6
6	13	Ave.	108.	103	15	Girl	71.
4	14	Boy	121.	78	16	Boy	92.
7	14	Girl	124.	88	16	Boy	107.
11	14	Ave.	123.	85.	16	Boy	95.
2	15	Boy	133.	....	...	Ave.	98.
2	15	Girl	109.	96	16	Girl	22.
4	15	Ave.	121 2	98	16	Girl	94.
1	16	Boy	105.	106	16	Girl	74.
3	16	Girl	113.3	100.	16	Girl	63.
4	16	Ave.	111.2	....	....	Ave	63.2
1	17	Boy	103	87	17	Boy	84.
2	17	Girl	124.	90.	17	Boy	116.
3	17	Ave.	117.	....	....	Ave.	100.
				95	17	Girl	26.
Average Boys			94.4	105	18	Girl	92.
Average Girls			100.6	107	21	Girl	91.
Average Boys and Girls			97.1	101	24	Girl	33.
				Average Boys			87.
				Average Girls			66.9
				Average Boys and Girls			77.6

4. RESULTS (See Table 36)

The normal pupils averaged 97.1 circles while the epileptics averaged 77.6. The normal pupils made on the average 1.6 circles a second, and the epileptics 1.3. The epileptics did 80% as well as the normal pupils. The epileptics

on the average did a little better than the nine-year group of normals, and made about 39 circles less than the oldest group of normals.

The normal boys did 93% as well as the normal girls, making on the average 6.2 circles less per minute than the girls, while the epileptic girls did only 77% as well as the epileptic boys, making on the average 17.1 circles less a minute than the boys. Among the normal children the girls did better in eight ages while the boys excelled in three ages, but among the epileptics the boys excelled in four ages and the girls in two ages, no comparison being possible in the other ages.

The rapidity of making circles among the normal pupils increased in eight ascending ages and decreased in two ages, namely, in ages 15 and 16. In age 15, 75% of the children were classed as bright, while in age 16, 75% were classed as dull and average. In this test the highest average was made by the 14-year-old children. The gain made by the oldest group over the youngest group amounted to 46.5 circles, or an improvement of 40%.

5. CONCLUSIONS

1. In speed of motor reaction, as measured by the writing of circles, the epileptics did 80% as well as our normal subjects. The epileptics on the average did somewhat better than the nine-year-old normal pupils. Our results are not in harmony with the conclusions of Smith, who says that the speed of tapping is not different in epileptic and normal individuals.

2. The normal girls reacted slightly more rapidly than the normal boys, while the epileptic boys reacted noticeably more rapidly than the epileptic girls. Earlier experiments with the tapping test have given discrepant results. With the Seguin form-board, which is a more complicated motor test than writing circles, or tapping, the boys have proved to be more rapid than the girls, especially during the first trial.[1]

3. The speed of motor reaction, in the form in which it is here measured, increases with ascending chronological age, at least to the age of 14. It is possible that the increase would have extended beyond 14 had more subjects been tested. In the tapping test the increase has been found to extend to age 18 by several investigators.

4. There are considerable individual differences even in this simple test. The difference between the lowest and the highest individual scores among the epileptics amounted to 94 circles (from 22 to 116), and among the normals to 102 circles (from 40 to 142). The difference between the lowest and the highest individual scores (number of circles) in each chronological age for the normal subjects was as follows:

Age	7	8	9	10	11	12	13	14	15	16	17
Difference	20	43	62	59	53	31	40	42	45	32	35

[1] J. E. Wallace Wallin. Psycho-Motor Norms for Practical Diagnosis, 1916, 54ff., 69, 71.

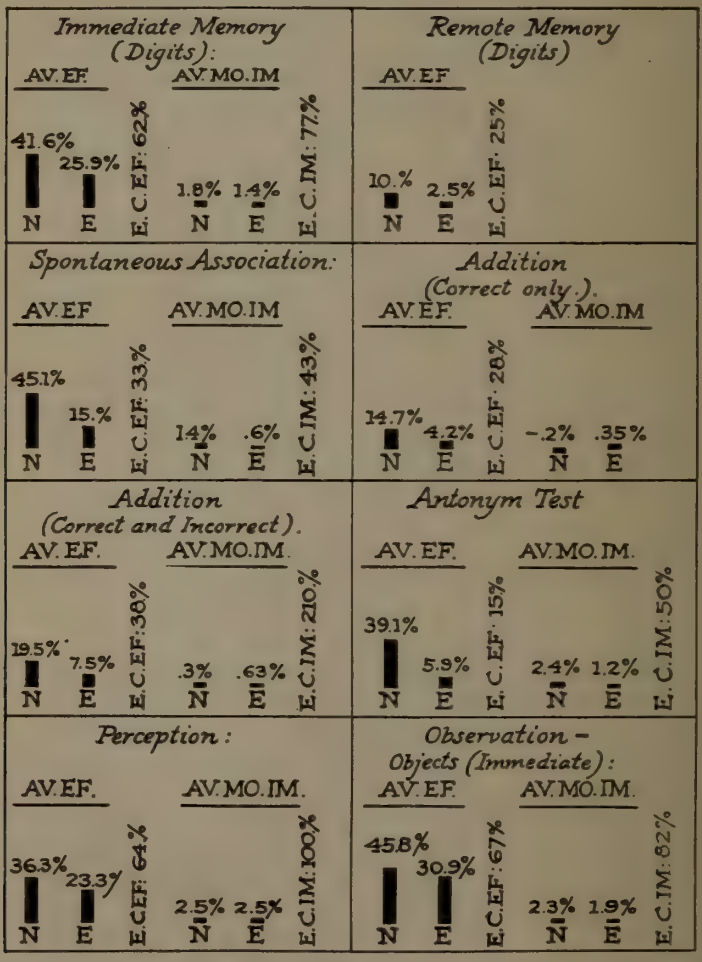
These significant differences in so simple a group test are explicable on the assumption that the rapidity of making circles varies with two factors, the one general and the other specific. It varies (a) more or less with the general mental capacity of the individual and (b) with the facility with which the individual is able to execute the necessary manual movements, which, in turn, varies with innate motor capacity and practice in rapid writing.

5. In spite of its simplicity this appears to be a useful test for measuring differences in motor capacity, and mental ability as well, as indicated by the increasing ability shown in the test with increasing chronological age among our normal children.

XIV. GENERAL COMPARISONS AND CONCLUSIONS

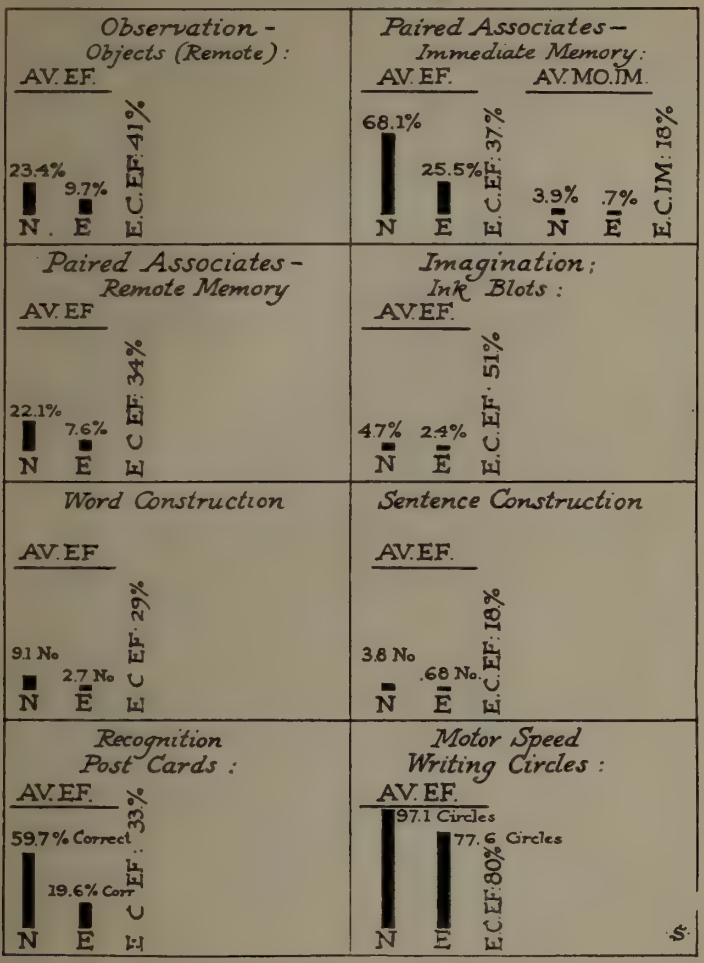
We present graphically on pages 162 and 163 the comparative efficiency and the comparative improvement (based only on the absolute units), of the normal and epileptic subjects, based on the group averages for all the sittings.

PSYCHOLOGICAL TESTS OF NORMAL AND OF EPILEPTIC SCHOOL CHILDREN



N—Normal. E—Epileptic. Av. Ef.—Average Efficiency. Av. Mo. Im.—Average Monthly Improvement. E. C. Ef.—Epileptics' Comparative Efficiency. E. C. Im.—Epileptics' Comparative Improvement.

PSYCHOLOGICAL TESTS OF NORMAL AND OF EPILEPTIC SCHOOL CHILDREN



N—Normal. E—Epileptic. Av. Ef.—Average Efficiency. Av. Mo. Im.—Average Monthly Improvement. E. C. Ef.—Epileptics' Comparative Efficiency. E. C. Im.—Epileptics' Comparativ Improvement.

1. The great inferiority in "comparative efficiency" of the epileptics is shown by the following facts: In only one test (writing circles) did the epileptics do as well as the nine-year-old normals, while in nine tests they did poorer than the youngest group of normals. In five of the latter tests they did only half, or less than half, as well as the seven-year-old normals, namely, in free association, antonyms, word construction, sentence construction and recognition. The epileptics did only 10%, or less than 10%, as well as the

oldest group of normals, the seventeen-year-olds, in two tests (antonyms and sentence construction), they did less than 26% as well as the seventeen-year-olds in seven tests, less than 47% as well in ten tests, and over 50% as well in only three tests (memorizing digits, imagination and writing circles). Comparing the averages of the entire epileptic group with the averages of the entire normal group, we find that in only one test (writing circles)did the epileptics reach 80% of normal efficiency, in only four tests did they average between 51% and 67% of normal efficiency (memorizing digits, crossing out A's, range of apprehension and imagination), while in the remaining eight tests they did less than 38% as well as the normals (we are counting the combined and the correct scores in the addition test separately). In about half of these tests the epileptics did less than one-third as well as the normals, namely, in the free association, addition based on correct scores, antonyms, word construction, sentence construction and recognition. The comparative efficiency of the epileptics in the various tests is as follows, given from the poorest to the best: antonyms, sentence construction, recognition, addition based on correct scores only, word construction, free association, paired associates (G), addition based on combined scores, imagination (ink blot), memorizing digits, A-test, range of apprehension, and writing circles.

The decided inferiority of the epileptics is clearly apparent. As we have already said, however, we believe that the tests exaggerate somewhat the intelligence deficiency of the epileptics as compared with the intelligence of the normal pupils, because the tests were administered collectively, in consequence of which all the responses had to be made in writing. We feel that had the tests been given individually, so that oral responses could have been secured in the tests which permitted oral responses, the epileptics would have functioned somewhat better, although many of them had had a considerable amount of schooling and practice in writing. All other things equal, the less schooling possessed by any group the lower would be its rank in these tests. Subjects utterly unable to hold the pencil or to write would, of course, not be able to function at all in the tests.

On the other hand, we believe that this series of group tests has given us a more correct register of the intelligence status of the epileptic group than we secured from the prior administration of the Binet-Simon tests to each subject individually. We should naturally expect this to be so, because of the known limitations of the Binet scale in use at the time of this investigation and because the group tests were given during five different sittings, each lasting about an hour, at intervals of 28 days. A single examination by means of these tests would have its value, for the tests, although not constituting an adequately comprehensive or complete scale, nevertheless explore a considerable variety of significant mental traits or functions. The series can be used for making a preliminary intelligence classification of children,

say, from 7 or 8 years to the end of the teens. For such a purpose it is only necessary to give the first tests in each set, i. e., A1, B1, C1, D1, etc. But to secure adequate norms a larger number of normal children must be tested.

The advantages of giving group tests of intelligence for purposes of grading the relative capacity of children are obvious. By means of such tests we can examine a large number of pupils at one time, while many children do better when working in groups, due to the incitement of social rivalry, than when working alone. We must recognize, however, that group tests also suffer from limitations, to which we have referred in the earlier pages of this work and elsewhere.[1] We do not consider it wise to attempt to make far-reaching individual diagnoses on the basis of performances in group tests. We refer particularly to the attempt thus to diagnose individual children as feeble-minded. The diagnosis of feeble-mindedness should always be made as a result of a clinical examination, but a "clinical" examination as to feeble-mindedness does not refer merely to the physical examination and the investiagtion of the personal and family history, but also (and what is more important) to the psychological examination. An individual psychological examination is as much "clinical" as a physical examination. It is probable that we can select by such group tests as these many of the subjects who require a further psycho-clinical examination. The value of these tests for the relative evaluation of different groups of individuals is, of course, beyond question.

2. The epileptics were inferior not only in the more complex, but also in the simpler tests, and not only in the more intellectual but also in the more sensory and the more motor tests. But the inferiority was greater in the more complex, difficult and intellectual tests. It is apparent, of course, that we cannot sharply distinguish between the intellectual, motor and sensory—and memory—tests. The difference is largely one of degree.[2] Mindful of this reservation, we may classify the tests as follows, giving the efficiency of the epileptics in each test in terms of the percentage of normal efficiency.

Intellectual		Sensory-Motor		Memory	
Free Association..	37%	Crossing A's.....	64%	Range of Apprehension....	67%
Addition, combined scores..	38%	Writing Circles.....	80%	Paired Associates...	37%
Addition, correct scores ...	28%			Recognition.....	27%
Antonyms	15%				
Word construction,.	29%				
Sentence construction.....	18%				

It will be seen that the relative efficiency of the epileptics is decidedly lower in the intellectual than in the sensory-motor tests, and most of all in

[1]The Mental Health of the School Child, 1914, p. 220ff Since this monog aph was written some doubt has arisen as to the value of group intelligence tests because of the discrepancies and lack of consistency found between different scales See The Theory of Differential Education as Applied to Handicapped Pupils in the Elementary Grades. Journal of Educational Research, 1922, 269ff; and The Consistency Shown by Intel igence Ratings Based on Standardized Tests and Teacher's Estimates. The Journal of Educational Psychology, 923, 231ff.

[2]Norsworthy grouped her tests into intelligence, memory and maturity tests. But here, again, the distinctions cannot be sharply drawn.

the two tests which perhaps are the most intellectual, the antonym and sentence construction tests. Comparison with the tests classified as memory tests is not very significant, because these tests, or at least two of them, might with equal justice be classified as intelligence tests. It would be practically impossible theoretically to arrange all of these tests in the order of complexity. But the three simplest tests are probably crossing A's, range of visual apprehension and writing circles (memorizing the digits was perhaps a simple, although a very difficult test). The epileptics did emphatically better in these tests than in the other tests, relatively to the normals.

Our conclusion that the epileptics, all of whom were either backward or feeble-minded, are inferior to the normals not only in the more intellectual and complex tests but also (although less decidedly) in the simpler and more sensory tests, does not harmonize with the conclusions of Binet and Simon, who investigated more elementary sensory processes than we did, that "in all grades of defectiveness the fineness of perception equals, or nearly equals, that of the normal individual."[1] This can scarcely be accepted as an "undeniable conclusion," from one test on the differential limen of weights, with only three defective subjects, and one test on the least perceptible difference in the length of lines, again with only three defectives, while the comparison norms were supplied by only one subject, a female cook of 23 whose social condition was "analogous to that of our hospital defectives." The authors do sometimes find a greater obtuseness in the sensibility of defectives, but they ascribe it to "inattention and automatism;" for the feeling of an "elementary sensation" requires no "superior processes," but "only that one be attentive for a moment." With respect to pain, however, the authors "willingly admit that imbeciles have generally a certain obtuseness," and that "sensibility to pain develops with the intelligence." On the basis of an association test on four mental defectives the authors also conclude that "this is a new argument to demonstrate that the association times are longer with normals than with imbeciles, without doubt because the former have more ideas to choose from."

Wylie, however, whose experiments were more numerous and based on far more subjects (varying usually from about 35 to 95 in the different tests) found the feeble-minded inferior to the normals, and the lower grades of the feeble-minded inferior to the higher grades of the feeble-minded, in practically all the sensory and motor tests which were given. The tests included strength of grip, motor endurance (only a slight difference probably due to the slow rate of tapping by the feeble-minded), speed of reaction, tactual sensitivity, pain (some were very obtuse, while others gave readings like normal adults, but the brighter among the feeble-minded were more sensitive than the duller ones), kinaesthetic sense (lifting weights), steadiness, taste

[1] Alfred Binet and Th. Simon. The Intelligence of the Feeble-Minded, 1916, p. 53ff.

sensitivity, minimal limen of color change, lowest and highest pitch, least perceptible difference in pitch, visual memory for form, color and letters, memory for non-sense syllables, associated words, and sentences, and memory of muscular movement.[1]

Smith gave the following tests to five normal and five demented epileptics and six normal persons, "attendants in the asylum," of "the same social class as the patients:" recognition; immediate memory; sensory discrimination; reactions involving movements and choice; rapidity of simple voluntary movement and maximal voluntary contractions. He found that the normals were superior to the epileptics and the normal epileptics to the demented epileptics, except in the discrimination of the lengths of lines and in the tapping of a key, where the results were about the same. His conclusion was that "both in the motor and sensory spheres it is the more complex processes which show themselves to be most affected."[2]

Norsworthy, on the basis of various tests of perception, kinaesthetic sense, form perception and rate of movement, accuracy of movement, memory of related and unrelated words, ability to form abstract ideas and appreciate relations and control associations, which were given to feeble-minded children who had been found eligible for instruction (thus exclusive of the lowest grades) and to "ordinary" school children, found that the feeble-minded were appreciably inferior to the normals in every test, but the inferiority was greatest in the abstract work and intelligence tests, and least in the maturity and perception tests. Their perceptive powers were found to be two and a half times as strong as their intellectual powers and almost half as strong again as their memory.[3]

In our prior study of subnormal epileptics we found that the strength of both the simpler and the more complex traits varied with the Binet-Simon age of the subjects. The data were analyzed for the following tests: time to name four colors, number of words given in three minutes (free association), time to read a selection and the number of memories, time to perform the Seguin form-board test and hand dynamometry.[4] From our Binet association test (free running association) we could not conclude, with Binet and Simon, that "If one gave a prize for rapidity it is the imbeciles who would win." Nor could such an inference be drawn from our association (B) test in this series, which more nearly resembles the test used by Binet and Simon. This may be seen from the following scores (averages of sittings 2 to 5) for the eight epileptics whom we regarded as having perhaps the lowest mentality[5] (all were classified as imbeciles in Table 3, although they could not be

[1] A series of articles by A. R. T. Wylie, in Journal of Psycho-Asthenics, 1900, IV, 109f; V, 16f, 54f VI, 54f.

[2] W. G. Smith. A Comparison of Some Mental and Physical Tests in Their Application to Epileptic and to Normal Subjects. The Journal of Ps[illegible]

[3] Naomi Norsworthy. The Psychology of M[illegible]

[4] Experimental Studies of Mental Defectives, [illegible]

[5] Nos. 108, 103, 87, 90, 95, 101, 86, and [illegible].

so classified at the time of our examination), and the eight having the highest mentality,[1] basing our judgment both on the Binet record and the school and industrial work of the patients at the time. All of the subjects in the best group, except two, were 12 years old or less (and all were less than fifteen years), while only three in the poorest group were thirteen or less. The scores for the poorest group are : 1.6, 7.5, 2.5, 7.5, 0, 5., 12.4, and 9.9; and for the best group: 12.4, 46.6, 37.7, 12.2, 9.9, 25.8, 35.8 and 25.8. The superiority of the best group is at once apparent. Only two of the epileptics in the poorest group do as well as the poorest epileptics in the best group, while one does as well as the second and third poorest in the best group. The median for the poorest group is 6.2 and for the best group 25.8, or over four times higher. When we turn to our perception test (crossing A's) and motor test (writing circles)—which are also our simpler tests—the superiority of the more intelligent epileptics is again manifest, although less decidedly so. The scores for the poorest epileptics in the perception test (E) are: 10.7, 19.4, 17.2, 0, 8.1, 10.6, 10.9 and 26.8; and for the best group: 19.1, 29.3, 37.7, 35.5, 27.7, 31.0, 21.6 and 35. Two subjects in the poorest group did better than the poorest in the best group, while one was equal to the second poorest in the best group. The median for the poorest epileptics is 14.0 and for the best, 35.1, or two and a half times better. The scores for the poorest epileptics in the circle writing test (L) are: 28, 71, 84, 116, 26, 33, 38 and 71, and for the best epileptics 75, 70, 87, 99, 113, 83, 87 and 85. In this, our simplest test, four of the poorest subjects did better than the poorest subject in the best group, while one in the poorest group did better than the best in the best group. The median for the poorest group is 54.5, and for the best group 86., or a little over one-half better. If we now turn to the hardest test in the series, supplying antonyms (D), the scores for the poorest group are: 0, 0, 0, 0, 0, 9, 0 and 1; and for the best group: 1, 3, 3.6, .9, .5, 21.6, .8, 8. and 22.4. The median for the poorest group is 0, and for the best group 2.4. Two in the poorest group equaled the scores of the three poorest in the best group, while no one equaled the median for the best group. It is obvious that in our results the defectives are inferior to the normals, and the lowest grade defectives to the highest grade defectives, in both the simpler and the more complex tests, and in the more perceptual as well as the more intellectual tests, but the deficiency is greater in the complex traits.

In Petersen and Doll's experiments on the minimal differences in the estimation of weights the feeble-minded were found to be slightly more obtuse and more variable than normal persons of the same mental age except in one age, but the differences are ascribed to intellectual rather than sensory factors.[2] In so far as concerns the efficiency of the senses in their practical uses this

[1]Nos. 81, 102, 104, 99, 84, 91, 97, 77.

The Anna M. Petersen and E. A. Doll Sensory Discrimination in Normal and Feeble-Minded Children.
[2]Training School Bulletin, 1914, November and December.

amounts to much the same thing. There is probably no sensory functioning which does not postulate intellectual processes. An absolutely "pure" and "simple" sensory experience is an abstraction of the analytical laboratory.

Terman claims that the weight test in the Binet scale, in which the difference between the weights amounts to three grams, does not correlate closely with "true mental age," while Binet and Simon conclude that the fineness of perception in imbeciles equals or nearly equals that of normal persons—a conclusion, however, which seems to have been based on the testing of only three defectives and one normal person. When we analyzed the data based on many clinic cases—in fact, 1000 consecutive children—we found that success in the test correlated quite clearly both with ascending intelligence age (Binet-Simon) and intelligence category. There was a decided increase in the percentage of successes in every ascending intelligence age except twelve and in every ascending category from the imbeciles to the accelerated group with one exception. We have found no basis whatever for Binet and Simon's conclusion, or Terman's statement, assuming that the Binet scale measures "true mental age," of which we knew practically nothing at the time the statement was made except from the use of the Binet scale. Our final conclusion, based on the analysis of extensive experimental data, was that "success in the weight test depends both on kinaesthetic and on intellectual factors, even in the simplest practical form in which it can be administered."[1]

3. The results bearing on the question as to which sex showed the greater efficiency in the tests are somewhat discrepant. In our dental squad the girls were superior in only one test and the boys in the other four, based on the averages for all the sittings. In this experiment the normal girls surpassed the normal boys in eleven tests, the boys excelled in one test, while the scores were equal in one, based on the averages of all the sittings. The girls' superiority ranged from 2% to 26%. In five of the tests it amounted to over 10%, and in two tests to 20% or over, while the superiority amounted to 7% or less in six tests. The girls were superior in all sittings (based on the averages, of course) in five tests and the boys in only one test. The girls were superior in three and four sittings in two tests each, while the corresponding figures for the boys are one and no tests. The girls were superior in eight ages in four tests, in seven ages in four tests, in six ages in three tests, in five ages in one test and in four ages in two tests; while the boys did not excel in eight ages in any test, they excelled in seven ages in only two tests, in six ages in only one test, in five, four and three ages in three tests each, and in two ages in one test. Thus in this group of New Jersey public school pupils the girls were clearly superior to the boys, although the difference

[1]The Individual Tests in the Binet-Simon Scale, Psychological Clinic, 1917, pp. 79-85. Since this article was written we have computed the percentage of successes for all the tests in the 1908 and nearly all the tests in the Stanford Binet scale, both for the intelligence age and for the diagnosis classification. If sufficient assistance can be secured these data will eventually be published.

between the sexes was negligible in at least five of the tests. On the other hand, our epileptic boys clearly excelled the epileptic girls, who were decidedly inferior in every test, based on the averages for all the sittings. The girls' inferiority ranged from 4% (in only one test) to 72%. In four tests it was over 50%. It was less than 20% in only three tests. The epileptic boys excelled the girls in all five sittings in all the tests except three. The boys excelled the girls in five of the ages that could be compared in four tests, in four ages in six tests, and in three ages in three tests, while the girls did not excel the boys in four or five ages in any test, but only in two ages in eight tests and in one age in four tests.

4. The efficiency of our normal school children increases in these tests with increasing chronological age. The only notable exception is furnished by the ink-blot test. There are, however, exceptions to the rule in some ages in every one of the tests. Thus if we compare age with age (average scores for all the sittings) there are losses in one ascending age in one test, in two ages in six tests, in three ages in two tests, in four ages in three tests and in five ages in one test (ink-blot). On the other hand, gains occur in six ages in three tests, in seven ages in three tests, in eight ages in five tests and in nine ages in one test. The losses are adequately explained, we believe, by the preponderance of backward cases in certain ages and by the fewness of the number of subjects. In no test, exclusive of the ink-blot test, is the score in the highest age less than 1.6 times as large as the score in the lowest age, in eight tests it is over twice, and in five tests over three times as large, while in three tests it is five times as large or more.

5. In absolute units the normal pupils improved more in the course of the experiment (based on the average gain made in all the sittings) than the epileptics in five tests (memory of digits, free association, antonyms, range of apprehension and paired associates), the epileptics gained more in the addition test, both combined and correct scores, while the gains were the same in the perception test. The amount of gain made by the epileptics in the first five tests varied from 19% to 82% of the normal improvement. The epileptics made the smallest improvement in the association tests, namely, paired associates, free associations, and antonyms. On the other hand, if we compare the six indices of improvement in each test (which give the gains as per cents of the efficiency scores in the different sittings), we find that the epileptics gained more than the normals in 27 of the total indices of tests A to G (the other tests are incomplete), the normals gained more than the epileptics in 18 indices, while the gains are equal in two indices. The normals did better in half of the indices in the antonym test, and the epileptics in half. Most of the epileptics' gains were larger than the normals' in the majority of the indices in the following tests: memory of digits, addition based on the

combined scores, perception and reaction, and range of observation; and smaller than the normals' in the majority of the indices in the following tests: free association, addition based on correct scores and paired associates.

On the other hand, a larger percentage of epileptics than normals either actually lost in efficiency or made no improvement (based on the average absolute gains for the five sittings), in all the tests except memorizing digits and range of observation, where the percentages of those who lost were the same for both groups. The difference was the greatest in the antonym and paired associates tests.

It is apparent, therefore, that the absolute gains are greater in a larger number of tests for the normals than for the epileptics, while the relative gains are larger in a larger number of tests for the epileptics than for the normals. We were scarcely ready for the latter result, in view of the belief, generally held, that epileptics as a class tend to improve very slowly and frequently actually dement and in view of the subsequent school record of the epileptics whom we tested. We have already suggested explanations for the discrepancy. (1) The large relative improvement of the epileptics is sometimes due to the very poor initial scores which they made. The normals initially functioned nearer their maximum and hence could not improve so much. (2) An abnormally large improvement sometimes occurred from a lack of comprehension of the problem at the start (e. g., in the antonym test), which prevented the subject from functioning in the initial tests. As soon as the problem is comprehended in such a test a large improvement naturally follows. (3) Owing to absences or zero scores it was frequently impossible to compute the indices. This introduced errors in the computation.

In view of these facts we believe that we are justified in concluding that the epileptics made less improvement in *genuine* mental capacity than the normals. Even after making the large gains which were registered in our tests the epileptics were still decidedly inferior to the normals. This inferiority would, we believe, have become increasingly patent after a longer lapse of time, owing to the gradual mental arrest or dementia which undoubtedly awaited some members of the group.

It may be noted that Norsworthy retested a number of feeble-minded and normal children after the lapse of a whole year, with results in harmony with our own. She found that the feeble-minded improved more than the normal in a few sensory and memory tests, but less in the intelligence tests. The lower grades of defectives improved more than the higher grades.[1] The greater improvement of the feeble-minded in the simpler tests is probably due to the fact that the normals, because of their keener intelligence, were able to adjust themselves properly to the tests at the outset and hence improved relatively less.

[1]Norsworthy, as before, p, 85f.

It is well to emphasize the positive bearing of our results on the training of epileptics. Our epileptics as a group—which may have been inferior to the non-institutional cases of epilepsy—certainly did make some improvement in most of the tests, although nearly all were suffering from convulsions at the time and although many of them were feeble-minded. Relieved of the seizures it is probable that the comparative records made by the epileptics would have been better. The first treatment of epilepsy, whether hygienic or medical, should aim to prevent or abort convulsions, but care must be taken that a form of treatment is not used which will produce worse secondary effects than the convulsions themselves. So far as the educational treatment is concerned the inference from our mental tests, as well as from our school experience with epileptics, is that the most profitable form of training to give the typical epileptic is sensory, motor and industrial in character, while the best form of occupation is outdoor employment. We question whether it is in the interest of the epileptic or of public economy to provide any considerable amount of literary training for the feeble-minded epileptic and the epileptic with destructive seizures. The literary training may well be largely restricted to mentally well-endowed epileptics whose seizures have been aborted, or at least do not produce mental impairment.

6. The normal boys perhaps improved slightly more in the aggregate in these tests than the girls did, since, although they gained less absolutely, they gained more relatively. Based on the average absolute gain for all the sittings the boys improved more than the girls in two tests (free association and addition, combined scores), the girls more than the boys in three tests (addition, correct scores, where they lost less, antonyms and perception), while the improvement was the same in two tests. On the other hand, the boys had a larger number of superior indices of improvement than the girls in five tests, while the indices were about equal for the boys and the girls in three tests. In the dental squad the absolute gains were larger for the girls in three tests and for the boys in two tests. The epileptic boys clearly gained more than the epileptic girls. The boys' absolute improvement was greater than the girls in six tests, while the girls gained more in only two tests. The boys had a larger number of superior indices of improvement in all the tests except one, in which the girls improved more than the boys in half of the indices.

7. There is little, if any, correlation between the age of normal pupils and the amount of improvement. If we compare the gains made in each successive age (i. e., the gain made in age 7 compared with age 8, age 8 compared with age 9, etc.) we find that gains occurred in a total of 36 comparisons in tests A to G, inclusive, while losses occurred in 33 comparisons. We have, however, made no comparison of the gains made by the youngest

group compared with the gains made by the oldest group. This comparison can be made from the tables.

8. The individual differences were marked in nearly all of these tests, even for normal children of the same chronological age. This may be shown by the following figures, which give (I) the smallest individual difference found in any given age in a given test (i. e., the difference between the lowest and the highest individual scores in the same age), and (II) the largest individual difference found in any age in the same test:

Test	A	B	C[1]	C[2]	D	E	F	G	H	I
(I).....	13.0%	13.6%	12.%	5.6%	13.4%	10.3%	4.9%	8. %	2.9 blots	3.8 words
(II).....	46.3	40.2	54.2	67.8	72.7	28.5	44.2	76.5	12.2	10.7

Test	J	K	L
(I)	1.6 sentences	2 cards correct	20 circles
(II).....	4.6 sentences	9 cards correct	62 circles

The importance of the question of individual differences in psychological experiments was emphasized in one of our earliest experiments, carried out in 1901,[3] and we have been forced to recognize the question in nearly all our subsequent investigations.[4] During the last decade or more many of the ablest psychologists and educationists have devoted a large amount of their productive energy to the investigation of the extent, causes and consequences of individual differences.

Three practical consequences follow from the demonstrated facts regarding individual differences. First, we cannot hope to establish reliable age standards in mental tests by the examination of a few subjects in each age. We need to test many subjects; the more we test the smaller will the mean variation become. Second, it is not safe to attempt to guage the mentality of a subject by giving only a few tests, unless the abnormality is so pronounced that we cannot fail to recognize it by means of a few tests. Ideally we should attempt to explore all the fundamental mental functions or traits, but these functions have not yet been charted. The number of tests used in this investigation are none too numerous. We would increase them rather than decrease them. Third, we should determine the amount of variation in any trait from the established age (or stage) norm which may be considered abnormal or pathological, and the amount of variation required in various traits to constitute different degrees of mental deficiency (e. g., feeble-mindedness, borderlinity, backwardness, brightness, precocity, etc.).

9. The utility of this series of tests (with individual exceptions) for the purpose for which they were designed, for use with children with mentalities of seven or eight and over, has been shown.

[1]Combined scores. [2]Accuracy scores.

[3]Optical Illusions of Reversible Perspective, 1905, pp. 111, 115, 120, 123, 136, 178, 227f, 309.

[4]Spelling Efficiency, 1911; see "variation" under "spelling efficiency;" Dental Cosmos, 1912, p.4^4f and p. 454f Experimental Studies of Mental Defectives, 1912, 37f, 42, 59f. Psycho-Motor Norms for Practical Diagnosis, 1916, 89f.

The value of the tests for measuring the relative mental *efficiency* of groups of children has been shown, first, by the fact that the efficiency tends to increase with increasing maturity (or chronological age) among the normal children. This increase is marked in view of the limited number of subjects and the unequal distribution of backward children in the different ages. From the point of view of the consistency and the size of the age increase all the tests seem satisfactory except the ink-blot test, and possibly the memorizing of digits and the recognition of post cards. In the second place, while all the tests were so difficult, as given, that the oldest or ablest normal children were unable to make a perfect score, yet practically all the tests were also so easy that most of the youngest normal children were able to score. A few of the tests, however, were too difficult for a considerable number of the epileptics and a few of the normals—e. g., the memorizing of digits, paired associates, antonyms and sentence construction. Some tests are subject to incidental weaknesses, e. g., the scoring in memorizing digits and apprehending objects.

The value of the tests for measuring mental *growth* and *improvement* rests upon the assumption that all the tests in the same set are equal in difficulty. We have given some facts in the earlier pages in support of the correctness of this assumption, so far as concerns a considerable number of the tests, while we have pointed out the incompleteness of some tests (e. g., word and sentence construction), the obvious lack of uniformity in one test (ink-blots) and the difficulty of making uniform series in another test (antonyms). If we may judge by the distribution of the best and the poorest scores in the different sittings, the tests seem measurably uniform, for if they are equal we would naturally suppose that the preponderance of the poorest scores would come in the early sittings and most of the best scores in the later sittings. As a matter of fact, confining the analysis to tests A to G, the poorest score by the normal pupils was made in the first sitting in five tests, in the second sitting in two tests and in the third sitting in only one test; while the epileptics made the lowest score in the first sitting in four tests and in the second sitting in two tests. On the other hand, the best score by the normals was made in the third sitting in only one test, in the fourth sitting in four tests and in the fifth sitting in two tests; and by the epileptics in the first and third sittings in only one test each, in the fourth sitting in two tests, and in the fifth sitting in three tests. We believe these figures show that the arrangement is fairly satisfactory. As we have already explained, however, the tests can be legitimately used to measure the *comparative* improvement of different groups of individuals, even though the series are not absolutely uniform in difficulty.

In the construction of this system of tests the distinctive purpose was to provide a half dozen variant forms for each test, in each of which the

materials, or constituent parts were to be differently arranged, but each of which, nevertheless, was to be of approximately the same degree of difficulty. In other words, the aim was to construct a set of uniform or unvarying scales for measuring the degree of mental growth or change which different subjects, such as the feeble-minded, epileptic, psychotic, backward, normal, or supernormal may undergo during various intervals of time, either as a result of the natural growth impulse, or as a result of various forms of treatment, training or handicap. The tests previously employed for this purpose had made use of identical test materials in each successive set, in consequence of which the results have been unduly affected by the factors of memory and familiarity, especially when the tests have followed each other at close intervals. Between the time of the devising of these tests and the publication of this study many group intelligence tests have been constructed in two or more variant forms of putative equal difficulty in which the components have been differently arranged.

Before this manuscript was completed a brief summary of the investigation and of the theories of epilepsy was published in the *Problems of Subnormality*, 1917, pp. 350-381.

I have been aided in the proof reading by Miss Mildred Rothhaar and Miss Charlotte Fiala.

I am under obligations to the World Book Company for the use of the graphs on pages 163 and 164.

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